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ARCHAEOLOGICAL EXCAVATION OF ROCK SHELTER No. 6 FROMM'S LANDING, SOUTH AUSTRALIA

By D. J. Mulvaney,[1] G. H. Lawton,[2] C. R. Twidale[2]

With specialist reports by N. W. G. Macintosh,[3] J. A. Mahoney,[4] N. A. Wakefield[5]

[1] Department of History, University of Melbourne
[2] Department of Geography, University of Adelaide
[3] Department of Anatomy, University of Sydney
[4] Department of Geology, University of Sydney
[5] Department of Zoology, Monash University

Abstract

Although the cultural material recovered during this excavation was meagre, it supplements and supports conclusions reached in the report on Shelter 2. A variety of other important evidence was recovered and is discussed. Geomorphological features are outlined, particularly relating to the question of the causes of rock shelter formation. C14 dates 1000 ± 91 B.C. (NPL 28) and 1220 ± 94 B.C. (NPL 29) establish the antiquity of a Murray R. flood, which is the highest on record. The age of an almost complete dingo skeleton is intermediate between these dates, and is discussed in Appendix 2. All organic remains were identified, and the mammalian fauna was compared in detail with that recovered from Shelter 2, 400 yds away. In the course of this study, a thylacine tooth was identified from Shelter 2.

Introduction

Although Mr C. P. Mountford noted the aboriginal shelters at Fromm's Landing as long ago as 1926, it was not until 1952 that a party of students under the direction of Mountford and Dr (now Sir) A. Grenfell Price, surveyed the site and provided the numeration of the individual shelters, strung along 500 yds of the cliff, which is followed in this report (Price 1952). In 1956 and 1958, Mulvaney excavated Shelter No. 2 and was able to demonstrate that the aboriginals occupied the area some 5,000 years ago (Mulvaney 1960). The 1952 survey party had made a shallow excavation in No. 6 which had revealed occupational debris, and it was decided to extend this exploration of the floor sediments, partly in order to compare and check with the nearby No. 2, and partly to provide training in archaeological fieldwork. The direction of the excavation was undertaken by Mulvaney.

In this paper, several features arising from the excavation itself are first discussed, followed by an account of the artefacts and bones discovered during the excavation.

The Excavation and Related Features

General

The Fromm's Landing sites are located at the base of high precipitous cliffs that bound the narrow valley of the Murray R. which winds through Mallee plains. Within the narrow valley there is, of course, permanent water, but the surrounding plains underlain by Miocene marine sediments and with superficial developments of kunkar and sand dunes are arid to semi-arid (Mannum, the nearest official recording station to Fromm's has an average annual rainfall of 11½ in.).

Shelter No. 6 has a level sandy floor and a commanding view of the river to the E. (Fig. 1). The shelter which stands some 33 ft above the river is extensive and comparatively high and deep. The floor falls away outside the confines of the shelter

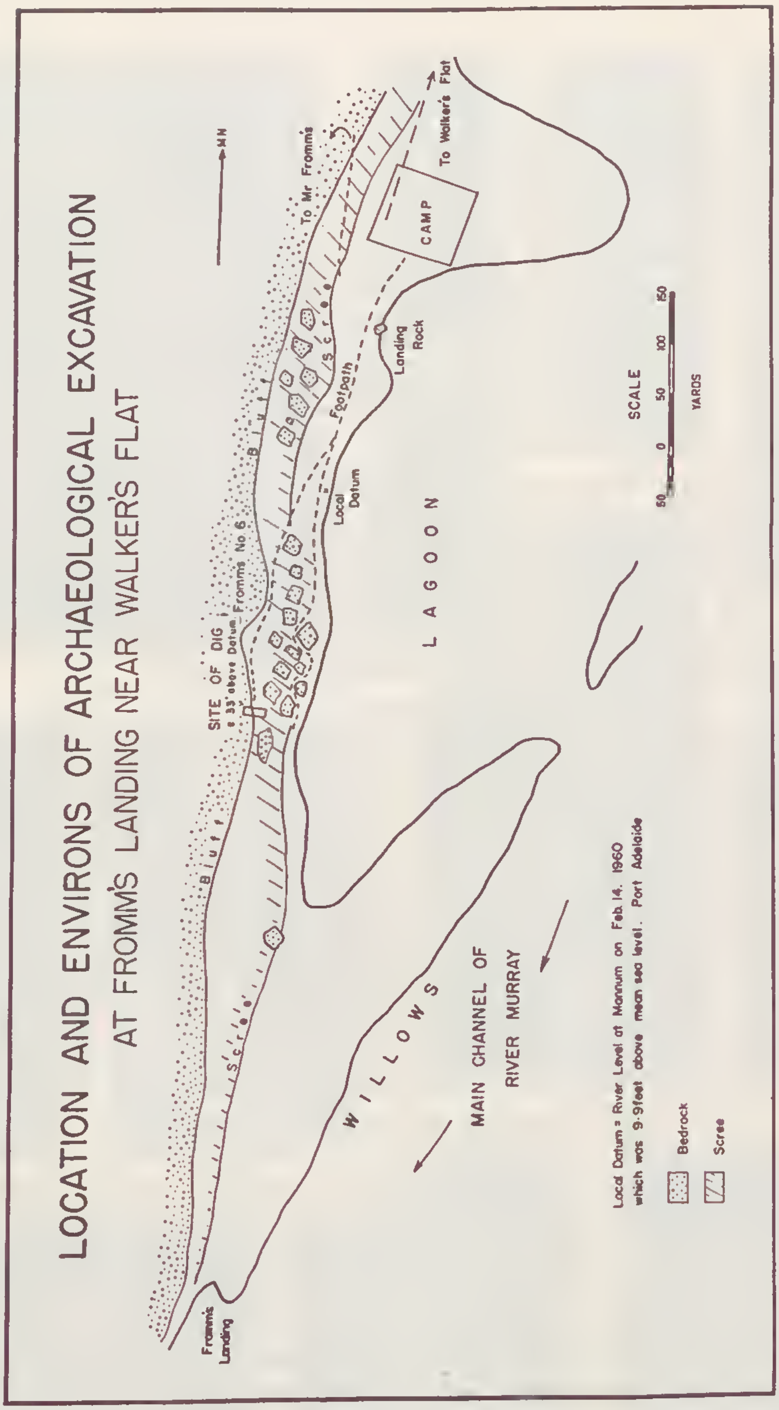

FIG. 1—Location and environs of Fromm's Landing.

and there is a steeply inclined slope down to the flats that border the present river channel. Above the shelter there are vertical cliffs about 75 ft high, eroded in richly fossiliferous Miocene calcarenite. Above the Miocene there are 20-25 ft of cross-bedded Pliocene sands with a massive oyster bed at the base. The shelter faces E. and is at present shaded by pepper trees, a function formerly performed by tall red gums. The initial excavation was made during a week in February 1960, and a further week in February 1963 sufficed to widen the trench to 10 ft and extend it for 28 ft down the slope from the backwall of the shelter. Work commenced by clearing out the rubble in the 1952 trench and extended out from both sides of that cutting. The excavation revealed a thick wedge of sediments, both natural and anthropogenic, resting upon an irregular bedrock surface (Fig. 2). As Pl. LXVIII testifies, the site provided a textbook demonstration of the reality of archaeological stratigraphy, with richly coloured bands of clean yellow sand, reddened sand, white ashy material, and concentrations of charcoal and mussel shells extending to a depth of 14 ft. All material was removed in layers by trowel, sieved and sorted. It was possible to break up all fallen boulders of Miocene calcarenite, thereby enabling the excavation to reach bedrock over the entire trench.

The number of artefacts recovered from the sediments was small, although the occurrence of a few type specimens enabled tentative correlations with other sites. However, there was some compensation for the paucity of the cultural record by other discoveries, including evidence for a high river level during prehistoric times and the fully articulated skeleton of a dingo from a depth of almost 6 ft in the excavation (see Appendix 2). Organic materials were preserved because of desiccation in the upper layers within the shelter.

Sediments

The unconsolidated sediments disclosed in the excavation fall naturally into two groups. The lower and earlier, consists overwhelmingly of fine to medium yellow* sands with large fragments of Miocene bedrock, and with only occasional hearths or their ashy bands and other occupational debris. The upper and younger sequence comprises for the most part occupational debris, mostly hearths and shells, with only thin bands of yellow sand.

[* All colour references are on the Munsell scale. While the following designations remain fairly consistent as regards Hue, Value and Chroma, the layers do vary in these qualities from place to place and the references may be taken as a guide only: Yellow 'clean' sand—2·5Y 7/6; grey-white 'ashy'—2·5Y 8/2; red sand, 'burnt'—2·5YR 5/8; brown (layers 3-4)—10YR 4/3; uniform grey, on weathered slope—10YR 5/2-3.]

Despite its vivid contrasts in colouration the composition of the deposit is basically similar throughout. It is medium to fine grained sand, derived from the disintegration of the Miocene parent rock. Mineralogically it consists principally of calcite. Variations in colour from one band to another are attributable in large measure to the vagaries of human activity.

The continuous bands of loose, clean yellow sand are a striking feature of the section (especially Layers 6, 10, 13, 16, 17, 18). While the presence of a few artefacts and bands of ash and shell testify that man was not wholly absent during their deposition, it is evident that the time of their deposition represented periods of virtual desertion by the aborigines.

It seems probable that the detritus of the yellow bands is derived essentially from weathering of the cliff and shelter roof. Ashy horizons occur within these layers. They are not stratified and do not in this respect compare with the one fluviatile sediment exposed in the section, nor are they related in any place with any sign of

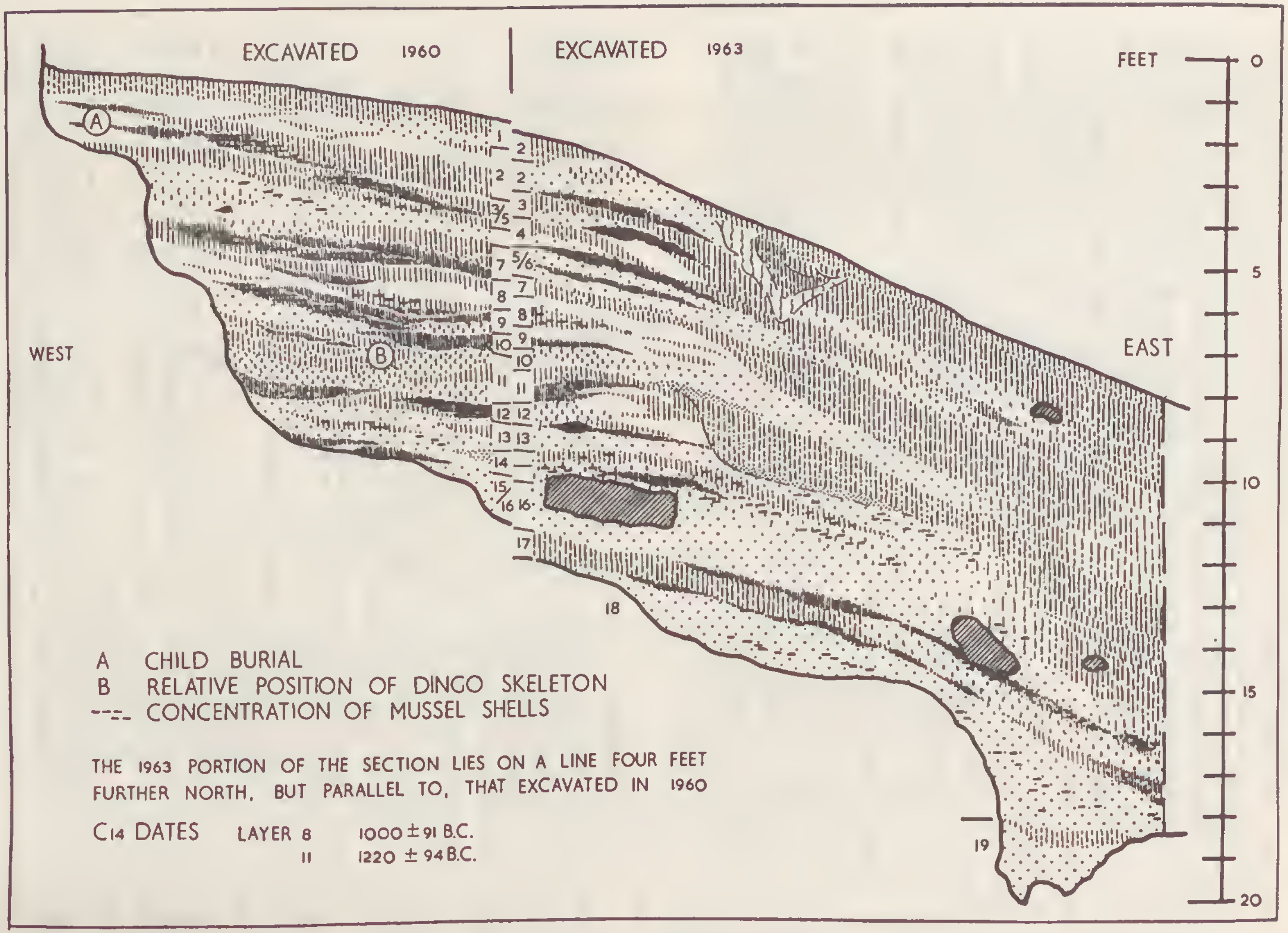

FIG. 2—Section of N. wall of trench.

river erosion. It is relevant that these layers contain numerous fossils derived from the local bedrock, especially *Lovenia forbesi* (from the Miocene) and *Ostrea sturtiana* (from the Pliocene).

But it is the analysis of the Miocene country rock, which occurs in the shelter roof and bluff, and its comparison with the material from the yellow layers which proves that the latter are formed directly as a result of the disintegration of the former. 20 gm samples of both materials were treated with dilute hydrochloric acid and then washed to remove colloidal material. Two other samples were washed with water alone in order to remove colloidal material but leave any calcium carbonate untouched. Results of the analyses are as follows:

Material	Wt left after acid on 20 gm sample	Wt left after water on 20 gm sample
Miocene calcarenite	2·91	16.06
Yellow layer	3·84	16·81

Thus the two samples are very similar. The rock consists of 65·7% $CaCo_3$ compared with the 64·9% of the yellow layer. Minor differences may be explained by the loss of some of the fine fraction of the weathered rock as a result of wind action.

It has been demonstrated that the yellow layers probably represent natural deposition during periods when aboriginal occupation was slight, while the high carbon content of the dark and grey horizons is chiefly the result of aboriginal camp fires. The reddened bands of sand are a problem. The visual evidence suggests that they were caused by intense baking beneath aboriginal fires; in places, the buried limestone cliff is reddened in contact with this sand. A similar phenomenon was noted in the upper layers at Shelter 2, inside the shelter and directly underlying hearths. But no matter how obvious the explanation to those who inspected the section, it was difficult to establish in the laboratory. Because the clay and fine silt fraction was so small, it was impossible to determine whether the heat produced brick aggregates. Microscopic examination was indecisive. The red stain was distributed fairly uniformly around the sand grains, and may be explained as precipitation of secondary iron hydroxide around them. If the reddening had been due to firing, it is probable that the colour would have been more intense on the side of the grain nearest the heat. It is questionable, in any case, whether the aboriginal fires would have been large and intensive enough to cause baking of the soil to a depth of some inches, or whether quartz grains could be reddened in this manner, but these are problems meriting further investigation.

It must be stressed that, except for the case of erosion due to the rise in river level discussed below, there was no interruption to the natural accumulation of layers on the site. Naturally, on the steep slope away from the shelter, tree roots, hillwash, and cliff fall complicated matters. The following strata could be traced over the entire trench, but even those which were discontinuous conformed to the pattern of these others: Layers 6, 10, 13, and the ash and shell bands in 16 and 17.

Layers 1 and 2 were loose and contained quantities of plant material, most of which must have been brought there by aborigines. The entire deposit was easy to trowel, except for Layers 8 to 10, where they were protected by the overhang. These were extremely consolidated and the deposit had to be removed in lumps and broken up with difficulty. The material consisted chiefly of the white 'ashy' sand. While this material included some charcoal, analysis failed to establish that the colour and apparent texture were due to a preponderance of ash. The flame photometer showed that it contained only about half the potassium present in the parent limestone of the cliff (2,500 p.p.m., compared with 5,400 p.p.m. in the crushed rock). However, this was greatly in excess of the water soluble potassium content of the reddened 'baked' sand (500 p.p.m.).

Bedrock Floor

An important incidental discovery as a result of excavation calls for special comment, as it opens the question of the causes of rock shelter formation. The upper part of the subdebris bedrock surface does not descend evenly; a series of distinct steps were uncovered, the angularity and distinctness of which diminish progressively downslope. There are four steps (Fig. 2), and this higher stepped section is more precipitous than the slope below. The lower slope is gently concave, not smooth in detail and displaying nothing suggestive of steps. The lowermost part of this section is very rough and pitted in detail, below which it gives way abruptly to a near vertical cliff which is blanketed by many coarse blocks of calcarenite and which at its lowest exposed point is only 9 ft above the present river level. It is probably a remnant of an ancient river bluff.

In the wedge of debris that rests on this bedrock surface, the lower strata of essentially non-occupational debris are associated with the broadly regular concavity, the upper mainly occupational layers with the stepped section. In detail, too, there is a clear correlation between units of the debris sequence and elements of the stepped bedrock slope for, consistently, the treads of the slope are associated with the thin yellow layers, the steps with the thicker occupational debris.

The consistency of this relationship is such that it effectively disposes of the possibility that the development of the bedrock slope and the deposition of the strata within the shelter are separate unrelated events. The steps are not related to structures such as joints in the calcarenite but are etched out of the massive bedrock. The treads cannot be attributed to successive periods of river corrasion, for there is no sign of riverine sediments in association with them; on the contrary, as has been shown above, the yellow layers are of local derivation.

The presence of the remnants of small caverns on the buried bedrock, at least in the upper areas, shows that in the past, as at present, the shelter extended back into the bluff principally by the initiation and development of these small cavernous forms. These occur in overwhelming abundance at the junction of air, bedrock and debris, that is, at the contact of the upper limit of the debris with the bedrock of the backwall.

It seems plausible that the stepped bedrock surface is connected with variation in the rate of debris accumulation in the floor of the shelter. During periods of non-occupation, as at present, the yellow layers slowly accumulate; at the rear of the cavern, near the top of the debris, caverns form and extend because the accumulation is so relatively slow that there is time for the caverns to extend back some little distance, coalesce, and form a more-or-less planate bedrock bench resulting from weathering. However, during periods of occupation, natural aggradation was appreciably augmented by hearth and kitchen debris. The rate at which the floor was built up, therefore, increased. The rate of cavernous weathering, on the other hand, proceeded as before, but more slowly relative to the more rapid accretion of the floor. The critical upper limit of the debris rose before caverns could develop to any significant extent and, in place of the benches of the periods of non-occupation, there were steeply inclined bedrock slopes. Thus, with alternations of occupation and non-occupation, there were variations in the rate at which the floor of the shelter was built up and, in consequence, variations in the rate of upward movement of the upper limit of the debris where, at its contact with the backwall, cavernous forms are most profusely and extensively developed. Thus, there are variations in the time available for the development of the caverns and, as a result, a stepped surface has been formed.

That this interpretation is correct is suggested by:

1. The constant correlation of yellow layer with tread, and occupational debris with step.
2. The fact that the upper stepped slope is associated with intense occupation generally and is also more precipitous than the slope associated with non-occupation in the lower section.
3. Similar relationships between type of sediment and the form of the bedrock surface were illustrated in his section independently by Mulvaney (1960) in his report on Shelter No. 2. A study of the published section from Devon Downs (Hale and Tindale 1930) suggests a similar stratigraphic situation there, although the relationship is less consistent.

This interpretation of the geomorphological pattern is relevant to the problem of the human exploitation of the shelter.

Yellow Bands and Non-Occupation

The reasons for the fleeting aboriginal visits during accumulation of yellow layers remains to be explained. It is possible to argue that the non-occupation, represented by the layers, results from epidemic disease or from massive walkabout for reasons unknown, but both are unlikely if only because of the duration of time represented by the yellow bands; by comparison with the thickness of non-occupational debris accumulated since the aboriginals abandoned the sites following white settlement, they represent periods of a century and more. There is, however, a physical argument that may explain the apparently periodic abandonment of the shelter, or at least that part of the shelter exposed in the excavation, though it is to be stressed that, until a much wider section is excavated, it will not be known whether the yellow layers are continuous strata or merely lenses, that is, whether the shelters were abandoned *in toto* at certain periods or whether only a part or parts were deserted at a given time and the entire shelter never wholly abandoned.

There must have been a critical minimum height for the shelters below which they were not occupied because they were physically uncomfortable,* and therefore not used save in case of urgent necessity. In caves that were high enough normally to be occupied, the floors were built up rapidly, more rapidly than the roof was raised by weathering. Thus, in shelters where the height was not much over the minimum, the aggradation of the floor would in time cause the height to decrease to such an extent as to be uncomfortable, and for the occupants to migrate either laterally or to another cave where there was more vertical space. During non-occupation, the build-up of the floor would be retarded comparatively but the weathering and raising of the roof would continue at the same rate as during occupation; however, the disparity between the two would certainly be reduced and probably reversed, for some of the debris falling from the roof migrated downslope as is clearly demonstrated by the excavated section, and it is certain in view of the fineness of the material (all passed through a $\frac{1}{8}$ mm sieve) that some has also been evacuated by wind. Thus, slowly the height of the shelter would increase until it again became suitable for habitation, when the cycle of events would recommence.

[* There are thick ash bands in Shelter No. 2 to within 2 ft of the shelter roof, indicating that the aboriginals may have sheltered and had sleeping fires in even very low caverns.]

There is no way of proving this hypothesis, but it is supported indirectly by the morphology of the bedrock slope beneath the wedge of debris exposed in the excavation, it being strongly suggested that this morphology is (most likely) the result of variations in the rate of floor accumulation as between periods of occupation and non-occupation; also, by the seeming periodicity of the occurrence of yellow bands in the section exposed, and the occasional hearths which occur even within the yellow bands and which could have been built either marginal to the fully occupied cave or during brief periods of 'population pressure' of the type suggested earlier.

High Level Fluviatile Deposits

Early in the 1963 excavation, it was noted that, in the N. face of the pit, several of the layers (11-13) of ash and kitchen refuse terminated abruptly downslope forming a buried bluff (Pl. LXIX). The reason for this became apparent when a layer of pinkish sand, displaying excellent stratification and clearly of riverine origin, was exposed at the base of the buried bluff; the ancient R. Murray, flowing high above its normal modern level, had cut a low bank in the occupational debris and had deposited at its foot some of the sand it had been carrying (Pl. LXX). The two-inch thick layer of sands apparently represents a single flood. The absence of coarser debris from the traction load is not surprising in view of the elevation of the deposit above the river bed and the nature of the bedrock for miles around; the river does not flow over rocks likely to provide gravels and the like. They are absent from the modern river bed at Fromm's. Moreover, modern experience is that when the river floods it does not necessarily flow at high velocities. This flood post-dated layer 11 (1220 ± 94 B.C.) and pre-dated layer 8 (1000 ± 91 B.C.).

When a survey was taken on 9 February 1963, the thin band of stratified river deposits was 21 ft above the river level of the day. How does this ancient inundation compare with high river levels recorded in historic times?

The highest flood on record at Walker's Flat and many other parts of the Lower Murray valley was registered on 5-6 September 1956 (S.A. Govt. 1962) when the river attained an elevation of 132 ft (all levels cited are 105·70 ft above low water at Port Adelaide). Pool level up to the Lock No. 1 at Blanchetown is 109·5 ft, so that the 1956 flood reached some 22·5 ft above pool level, which may be regarded as 'normal' for this sector of the river. On the day of the survey of the archaeological site at Fromm's Landing, river level at Mannum was only 0·01 ft below pool level so that it is valid to compare the 21 ft of the ancient flood with the 22·5 ft of the 1956 flood without any adjustment for river level at the time of survey. Thus, at first sight, it seems that the flood of 3,000 years ago was lower than the 1956 flood, but allowance must be made for a number of factors in order to obtain a true comparison of the two.

First, the ancient flood pre-dated the completion of the Goolwa Barrage (1940) at the Murray mouths which caused a rise in the general river level below Blanchetown of the order of 2 ft; and which, incidentally, caused many river meadows to be permanently inundated and many majestic river gums to be killed. Thus the 1956 flood is measured in relation to a river level 2 ft higher than the pre-1940 level. On this account alone, the level of the ancient flood is worth not 21, but 23 ft by 1956 standards.

Second, it is known that sea level has fluctuated widely during the last million years or so as a result of the waxing and waning of glaciers. For example, about 10,000 years ago, when glaciers were larger than they are today, it seems likely that sea level stood about 100 ft lower. If all modern ice masses were to melt, sea level would rise considerably and many great cities, as well as extensive coastal plains, would be inundated. Thus, as all river levels and especially those near the coast and of gentle gradient, like the Murray, are closely related to sea level, flood levels must be assessed in relation to sea and river levels prevalent at the time to which reference is made. Fortunately, during the past 4,000 years, sea level has suffered only minor fluctuations, probably all within a foot of present average ocean level. It seems possible that 3,000 years ago, during the period when the ancient flood occurred, sea level and hence river level was only some 6-9 in. lower than at present. Thus, on this account, the relative worth of the 21 ft of the ancient flood must be raised to 23·5 ft.

Thus, the flood of about 1100 B.C. was apparently higher than that of 1956. Certainly a far heavier rainfall is represented. The deforestation of the Murray catchment since white settlement, especialy in the head-waters, has probably increased the rate of run-off to the river and made for conditions conducive to flood development. The figure of 22·5 ft cited for the 1956 flood is, in any case, the measured maximum level of the river, whereas the 23·5 ft calculated for the ancient flood of 3,000 years ago is the absolute minimum elevation for the highest peak of the flood; the river has left behind evidence of its former presence at this elevation, but it certainly extended higher, though its upper limit is unknown.

Thus, it is safe to refer to the flood of 1100 B.C. as 'the highest on record'.

Climatic Change

In the discussion above it has been tacitly assumed that no significant climatic changes have occurred over the past 5,000 years. A comparison of the flora, fauna, and molluscs of earlier times (as evidenced from remains in archaeological layers) and the present (Mulvaney 1960), supports this view (cf. Appendix 1). But it must also be pointed out that the Murray valley environment is in a sense alien to the regions surrounding it. The water of the river provides a reasonably constant basis for life in the valley and climate changes would have to be large indeed to bring about a change in the environment of the valley floor. Investigation in the more vulnerable or susceptible adjacent hill and plain areas will prove a safer guide to the climatic history of the region than does the Murray valley.

Archaeological Discoveries

Artefacts: Description

The artefacts were few in number and of limited diagnostic value. The total number of retouched stone and bone specimens is provided in Table 1, together with the totals of struck flakes and other fragments. The description of all retouched pieces follows. Implement nomenclature follows McCarthy's scheme (1946).

Layer 2

A thin brown chert flake 2 cm × 1·5 cm, with traces of retouch or use fracturing on 3 edges; a rough quartz core, approx. 1·5 cm in diameter. 1 fragment of brown ochre.

Layer 4

A split bone 7·5 cm long (probably macropid tibia), cut to a point, but no evidence of grinding is present. A small brown jasper scraper, the flake possessing several narrow flake scars and slight retouch around most margins; a small brown chert flake with minute utilization fracturing on one edge.

LAYER 6

A chunky quartz fragment (4 cm × 3 cm × 1·5 cm) with attempted abrupt retouch around one curving edge, and best explained as a crude adze; a small quartz core.

LAYER 7

A small grey chert adze flake (burren type), broken in half, measuring 2·5 cm × 1·5 cm; a broken fragment of similar chert, possibly part of another adze flake; 2 quartz pebbles, one of them broken, both used as hammerstones; 2 chert and 2 quartz flakes, all showing slight traces of utilization although it could not be classed as deliberate retouch.

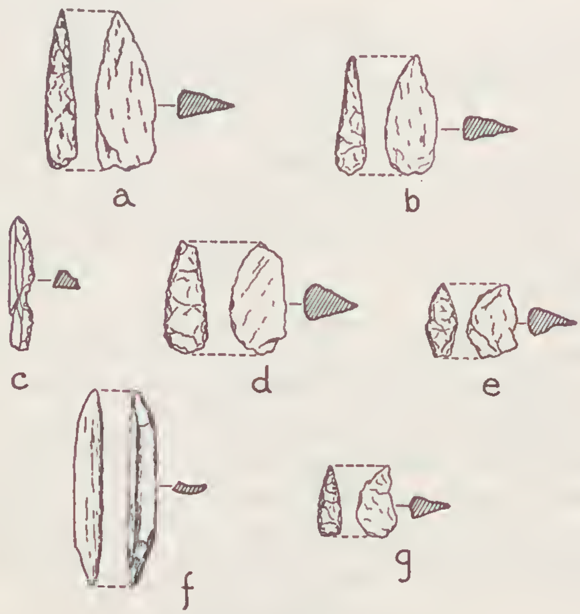

FIG. 3—Artefacts.

LAYER 8

1 bone point, 4 cm long, with tip broken and slightly flattened at base. 1 steeply retouched (burren) adze flake of grey chert, measuring 3 cm × 1·5 cm × 1·5 cm; 2 asymmetrical microlithic points of white quartz, 3 cm and 2·3 cm in length respectively, and trimmed along one margin (Fig. 3a, b). Although the trimming is rough, the stone is very intractable and this renders their fabrication more meritorious. Some might classify these points as Bondiain. 1 thin sliver of quartz, 2·5 cm in length (Fig. 3c), bears traces of trimming along one edge and may represent an attempt to produce a similar point. 1 pink-veined quartz of triangular section, 2·2 cm × 1·2 cm × 0·9 cm, with steep blunting retouch and/or evidence of use-fracture on both edges of the thick margin while the edge formed by the intersection of the two other sides is sharp and straight (Fig. 3d). This artefact is difficult to categorize. At first sight it resembles an elouera, but it is better described as a thick-backed microlithic point, with the tip of the pointed end broken off. Another specimen, 2·7 cm × 1·5 cm × 1 cm, roughly shaped from white quartz may be a crude attempt at fashioning a similar artefact. Also present was a small fragment of veined

quartz which may be part of a similar backed point, although it is more plausible to explain it as part of a geometric microlithic crescent (Fig. 3e). There are 5 quartz and 1 chert flakes or fragments which, with an effort of the imagination, might be described as utilized. There was 1 small quartz core. Two flat, broken river pebbles may have been used as hammerstones, but there are no obvious indications of percussion.

Layer 9

A brown patinated chert adze flake of tula type, 3·5 cm × 1·5 cm × 1 cm; 6 broken chert fragments, all bearing evidence of edge fracture, similar to that on adze-flakes, but too generalized to permit definite attribution; 6 quartz and chert flakes, which could be leniently described as 'utilized'; a stubby quartz point 3·3 cm long, with some suggestion of trimming along one edge (but not resembling any known type); 4 small quartz pebbles with considerable abrasion, presumably used as hammerstones; 2 flat, fine-grained sedimentary fragments of no obvious function.

Layer 10

A round bone, 4·5 cm long, ground to a sharp point and broken at the other end. 1 grey chert adze-flake (burren type ?), 3·5 cm × 1·7 cm × 1·3 cm; another probable adze specimen, broken in half; a small quartz flake with considerable edge fracture, suggesting its identity as an adze-flake; 3 chert pieces, possibly 'utilized'; a rough unifacial quartz primary flake, approximating leaf shape, but with no evidence of retouch and too rough to claim as a 'pirri blank'.

Layer 11

5 small rounded river pebbles, used as hammerstones; 1 large core.

Layer 12

A simple bone point, 3 cm long, ground to a sharp point. A flat flake of grey chert, utilized, but too indefinite to classify.

Layer 14

A red jasper scraper, finely retouched around ⅔ of the margin, 3·3 cm × 1·7 cm. As the main scraping edge is curved, it is best explained as an adze-flake in new condition. It is worth noting that a small primary bladelet, bearing further delicate flake scars was present, and this must indicate that craftsmen were capable of precision flaking techniques.

Layer 16

1 split bone, 4 cm long, cut at each end to asymmetrical points. Although not a 'text-book' example, it might be classified as a muduk (Fig. 3f). 1 geometric microlithic crescent made from milky quartz, 1·4 cm × 0·8 cm (Fig. 3g). This specimen has vertical blunting retouch on the back, and one tip is broken off, apparently representing ⅕ of the length of the specimen. 2 small flakes, designated 'utilized'; 1 small milky quartz core, 2 cm diameter.

Layer 17

1 broken flake of amber coloured chert, 'utilized'; 2 milky quartz cores, 3 cm and 2 cm in diameter respectively.

Layer 18

1 flake of fine-grained grey chert, doubtfully 'utilized'; a fragment of brown ochre.

TABLE 1

Layer C 14B.C.	Total Flakes etc.	Bone Points	Adzes	Geometric Microliths	Microlithic Points	Scrapers	Nondescript Scrapers or Used Pieces	Hammer Stones	Cores	Ochre
1	15									
2	19					1			1	1
3	3									
4	31	1				1	1			
5	0									
6	8		1						1	
7	132		2				4	2		
8 (NPL 28) 1000±91	363	1	1	1?	5?		6	2	1	
9	249		1				13	4		
10	279	1	3				3			
11 (NPL 29) 1220±94	161							5	1	
12	65	1					1			
13	24									
14	42		1				1			
15	3									
16 (NPL 63) 1500±90	36	1		1			2		1	
17	41						1		2	
18A	8						1			1
18B	5									
TOTALS	1484	5	9	2	5?	2	33	13	7	2

DISCUSSION

The report on Shelter 2 (1960, 73) deplored the meagre return of artefacts; but by comparison with the present site, the aborigines who occupied it were prodigal with their material culture. The total number of definitely classifiable retouched stone implements numbered 18 in a sample of approximately 1,500 stone flakes and fragments, while there were only 5 bone tools. The raw materials were similar in origin to those at Shelter 2. Quartz was most characteristic, while chert and small samples of quartzite, sandstone, granite, and schists made up the rest. There is no reason to believe that any of it was derived from sources of supply more distant than 20 miles.

Until further radio-carbon 14 dates become available, it is impossible to give an absolute date for the earliest occupation phase, but it seems possible that it was not as ancient as Shelter 2, which dated from about 3,000 B.C. It is interesting to observe that the rate of deposition of the upper layers at both sites appears comparable. The age of Layer 8, 4′ 6″ below the surface, was 1000 ± 91 B.C. (NPL 28); Layer 11, 7′ down, was 1220 ± 94 B.C. (NPL 29). At Shelter 2, a sample 6′ from the surface dated from 1290± 80 B.C., and another from 8′ was 1806 ± 85 B.C. The greater depth of the Shelter 2 deposit may therefore represent a longer period of deposition. This is supported by a date for layer 16, Shelter 6, of 1500 ± 90 B.C. (NPL 63), at a depth of 9′.

With type implements so rare, it is difficult to discern a cultural sequence in the assemblage, or to compare it with that obtained only 400 yds away in Shelter 2. The visual evidence for the intensity of settlement in the upper 3 ft of the deposit is apparent even in the photographs, yet the relevant layers—1 to 6—produced only 3 retouched stone tools, a single bone specimen, and 5% of the primary flakes. It is a sobering thought for the prehistorian who is dependent upon material traces for his cultural classification, that this constitutes the totality of the cultural attainments of the aborigines during almost 3,000 years of residence in this well situated habitation—a time span greater than that separating the Parthenon from the atomic bomb.

At least this negative result reproduced the pattern of the upper layers at Shelter 2 and at Devon Downs. Hale and Tindale (1930, p. 204) termed their assemblages of 'degenerate stone industries', Murundian, and supplemented it by including perishable ethnographic specimens recorded in the region a century ago. But the archaeological identity of this culture still requires confirmation, for a dearth of evidence is a dubious diagnostic feature. It is also premature to assume that the utilization of organic materials during the last century had persisted unchanged throughout more than two millennia. It seems possible that the term Murundian should be restricted to this riverine area. Following Golson's New Zealand experience (1959), it might be appropriate to consider the Murundian simply as a late-prehistoric variant, or aspect, of aboriginal society in southern Australia—a regional adaptation in which stone working was an insignificant element. The wide geographical application of the term is misleading at this stage of prehistoric research.

The occurrence of 5 quartz points in Layer 8 is interesting. Two of them have some characteristics of Bondi points, another two superficially resemble elouera. However, study of these few, rough specimens has highlighted an important problem awaiting closer definition. It seems probable that the terms 'elouera' and 'Bondi point' at present include a variety of types, with considerable merging of one type into another. Campbell and Noone (1943a and b) drew attention to some of the complexities in the South Australian situation, but a study of a collection of Bondi points from L. Illawarra, N.S.W., suggests that there are similar complications in that material. Campbell and Noone (1943, p. 379) discerned that, in addition to the conventional Bondi points and Woakwine points, there was a further type which they termed South East Bondi point. It is possible that the Layer 8 points are related to this latter category. Strict typological investigation of the backed point and 'eloueran' industries in Australia is the prerequisite for definition of this scant Fromm's materal. E.g., on quartz specimens, there is no indication of the technological process by which the primary piece was obtained; it is impossible to term them flakes or blades in these circumstances, whereas a true Bondi point is made on a flake or blade. Further, the thick-backed points seem too thick to be geometric microliths, but too pointed and carefully trimmed to be elouera.

Any definitive study should also re-investigate the meagre stratified artefacts from other sites. At Shelter 2, a possible elouera was claimed from a level dating from 1931 ± 85 B.C. (Mulvaney 1960, p. 68): Another single specimen was illustrated, though not identified as such, by Hale and Tindale (1930, Fig. 195) from Devon Downs, Layer 8 (Layer 9 was dated to 2245 ± 140 B.C.). At Fromm's 2, Layer 2 contained a classic Bondi point (1960, p. 79), while rough quartz microlithic points occurred in layers 0, 1 and 3 (1960, p. 61-66). These points should be compared with the specimens from Shelter 6, Layer 8, a hearth in which dated from 1000 ± 91 B.C.

The antiquity of the geometric microlith, which was established by the excavation at Shelter 2, receives added confirmation from the occurrence of a good specimen in Layer 16 (1500 ± 90 B.C.), and another probable specimen in Layer 8. It may be relevant to the vexed problem of their function, that each specimen lacks one tip; 3 microliths out of the 8 recovered at Shelter 2 had been broken.

No pirri points were recovered during the excavation. At Shelter 2 they preceded

1806 ± 85 B.C., and it could be argued that their absence is because this site was unoccupied until after their production ceased. Future C14 dating may confirm this, but it is relevant that, at Shelter 2, the pirris were associated with microliths, two of which were present at Shelter 6.

Tindale's use of the cultural term Mudukian has been criticized in detail elsewhere (Mulvaney 1960, p. 76; 1961b). Tindale (1957) claims the microlith and bone muduk (fish gorge) as the type implements of the Mudukian culture. But these types have not been excavated in satisfactory stratigraphic association. At Shelter 6, however, a microlith and a probable muduk came from layer 16, and Tindale may consider his claims vindicated. In the opinion of one of the writers (D.J.M.), this discovery has not invalidated his criticisms. Even if it is admitted that the evidence from Shelter 6 supports the Tindale sequence in a general way, it is difficult to invoke invasions or major cultural infusions to explain its history. It remains a plausible interpretation (as in Mulvaney 1960, p. 74) to stress the basic continuity of cultural tradition and explain changes in the industry between layers as resulting from environmental adaptation.

Only one conclusion is possible. The sample from this site is so small that definitive judgements are impossible. For a so-called stone age people, the aborigines were extraordinarily averse to using stone.

Human Burials

Burial 1

The well preserved bones of an infant, about full-term (Pl. LXXI A).

The flexed skeleton lay in a bundle in a circular grave, approximately 12 in. in diameter and similar in depth. The grave was lined with grass, some of which was charred, and was situated in the NW. corner of the trench, in the dry, ashy deposit less than a foot from the rear wall. The burial was relatively recent. It occurred in Layer 1 times, when floor level was only a few inches lower than at present. The bones were wrapped tightly in a cover of plant material, so decayed and discoloured that it resembled animal skin. It was tied in two places with vegetable fibre twine, the twisted strands of which were clearly distinguishable. Several bones were missing, including 4 vertebrae, and this suggests that the body was carried around for a period before burial, because there was no evidence of post-burial interference which could explain their absence.

This burial conforms to the ritual practice in the area at the time of European settlement. Eyre (1845, 11: 344) noted that a child who died under 4 years of age was transported in a bundle by the mother for some months until the body was desiccated. In Layers 1 and 2 there were large quantities of leaves and vegetable fibre lying in matted lumps. The great bulk of this fibrous material is referable to the common riparian sedge *Scirpus fluviatilis*, Marsh Clubrush (or 'river bulrush'). It is probable that this had been chewed by aborigines in the process of manufacturing string. Tindale and Mountford (1936, p. 497) excavated similar fibrous material at Kongarati cave. Taplin (1879a, p. 40) observed the Lower Murray aborigines make twine from two fibres, and his description is relevant. 'One is a blue rush which grows in the scrub; the other is the root of a . . . bulrush . . . the rushes or roots are first . . . boiled or steamed in the native oven, and then chewed by the women. A party of them will sit round the fire and masticate the fibrous material by the hour . . . the masses of (chewed) . . . fibre are handed to the men . . . who . . . work it up, by twisting it on the thigh into hanks of twine . . .'

Price (1952, p. 26) recorded the discovery of another infant burial in Shelter 6, at a depth of about 2 ft. The bundle was 'wrapped in a kangaroo skin'. This burial came from within the area of the trench excavated by the expedition described in this report.

Burial 2

The skeleton is that of a small, adult female aboriginal. It is well preserved, as such thin, fragile bones as the lacrimals and nasal conchae are present (Pl. LXXI B).

The grave had vertical sides, 50 in. in depth and was 30 in. in diameter. The S. line of the trench cut through the grave, situated about 6 ft from the rear wall and under the protection of the overhang. The burial took place during Layer 2 times and was dug down into Layer 8, almost down to the hard white deposit which encased the dingo skeleton, directly below the grave.

The grave was too small for the body, with the result that the head and feet rested at an angle to the body, the cranium sitting at right angles to the long bones. The body lay on its left side, facing the E. (the spinal column running 150°-330°). Eyre (1845, 11: 344) describes a similar ritual amongst the Adelaide tribe, but adds that burial took place 'with the head to the west, in a grave from 4 to 6 feet deep'. In this case, however, the skull gazed steadfastly across the river towards the E. Included in the infilling were 10 large pieces of rock, one of which rested directly on the cranium. However, the only damage caused by the pressure was the splitting of two upper incisors.

Traces of plant remains were found over some long bones, and the skull. These belonged to the sedge family, probably *Scirpus fluviatilis*. The evidence suggests that it may have been buried as a desiccated bundle, after the fashion described by nineteenth century observers. Taplin (1879a, p. 20; 1879b, p. 37) refers to the smoke drying of adult bodies on the Murray, after which they were 'wrapped up in mats' or 'rugs' and kept for a considerable period before their interment. Although he does not elaborate, it is obvious from a subsequent plate in which Taplin (1879b, p. 64) illustrates aboriginal handicraft, that the mats to which he referred were woven from plant materials.

Special features of some bones:

Skull: This is in good condition, the styloid processes and the lacrimal bones (1 damaged) are present. The posterior part of the skull is more friable than the anterior. Most suture lines are present, including at least part of the coronal and most of the lambdoid: the sagittal suture is synostosed. The supra-orbital ridges are poorly defined and the mastoid processes are small. The palate is wide anteriorly. The teeth showed marked attrition, especially the molars where the attrition is most advanced on the inner aspect of the upper molars and the outer aspect of the lower ones. The first right premolar is missing; judging from the bone resorption, it was removed some years prior to death. There is no caries. The mandible is well developed with a large coronoid process. The angle between the body and the ramus is greater than a right angle. Hyoid bone: There are no lesser cornua present. Clavicle and scapula: Small and light bones. Left Humerus: There is an old fracture of the mid shaft with a definite deformity on the anterior aspect of the lower shaft. Right fibula: There is a slight bony deformity just below the upper end of the bone, probably the result of an old fracture. Hip bones and sacrum: Show the characteristics of those of a small female. Lumbar vertebrae: The bodies show definite lipping of their edges. One mid-thoracic vertebra: Has a poorly developed body, which is thin and wedge-shaped (with the narrower part anteriorly). The two sides of this body are not fused in the midline where there is a gap of varying width (maximum width ¼″).

Age: Judging from such criteria as tooth attrition, suture line fusion and lipping of lumbar vertebral bodies she was probably over 40 years and probably not in advanced age.

ORGANIC REMAINS

Detailed appraisals of mammalian fauna are given in Appendices 1 and 2. A summary of other relevant finds follows.

MOLLUSCS: The freshwater and terrestrial molluscs followed the same pattern as those reported in detail from Shelter 2 (Mulvaney 1960). There were 2 species present at Shelter 6 which had not been recorded at Shelter 2. *Salinator fragilis* Layers 9, 10) and *Chloritobadistes victoriae* (Cox)? in Layer 18. Bivalves, *Velesunio ambiguus* (Philippi) and *Alathyria jacksoni* Iredale, were abundant in all layers, although there were concentrations in bands at some depths. *Corbiculina angasi* (Prime) was also present in all layers.

Univalves present in almost all layers were *Notopala hanleyi* (Frauenfeld), *Plotiopsis tetrica* (Conrad), and *Lenameria tenuistriata waterhousei* (Clessin). The small land snail, *Austrosuccinea australis* (Ferussac), which was recorded in almost all levels at Shelter 2, only appeared in lower layers here. *Meracomelon* sp. ? appeared in Layer 15.

AVIFAUNA: Shell fragments of emu eggs were present in most layers, in addition to some bones of birds otherwise unidentified. Possible Mallee fowl egg shell in Layer 11.

REPTILIA: Fragments of carapace of *Chelodina* occurred in almost every layer. *Tiliqua scincoides* or *Trachydosaurus rugosus* occurred in Layers 4, 7, 8, 10, 11, 14, 15, *Varanus* in Layer 2.

PISCES: Fish vertebrae were common, although few were specifically identified. *Oligorous macquariensis* (Murray cod) was identified in Layers 17 and 18. An upper jaw fragment of a large specimen was found in Layer 16; a probable catfish spine in Layer 11. *Parachaerops* (Yabbie) was preserved in Layers 1, 2, , 5, 10, 11, 14.

FLORA: Large quantities of *Scirpus fluviatilis* (Marsh Clubrush) occurred in Layers 1 and 2 and in association with burial 2; carbonized fragments were recovered in Layer 5. Layers 1 and 2 also contained numerous twigs and leaves of eucalypts. *Santalum acuminatum* (Quandong nuts) occurred in Layers 1, 2 and 5.

Appendix 1

MAMMAL REMAINS

By N. A. WAKEFIELD

In the material excavated from Shelter 6 at Fromm's Landing, there were specimens of about 96 individuals of native mammals, representing 12 species. The identities of these, and their distribution in the levels, are set out in Table 2. In this table some of the figures given are based on identifications and counts are based on jaw bones.

Mulvaney (1960) gave lists of mammal genera and a few species, for the various levels of the excavation of Shelter 2 at Fromm's Landing. This material has been re-examined and identified at species level. As there are 30 species and several hundred individuals represented, it is a valuable collection, particularly as several of the levels have been dated. Table 3 presents an analysis of the mammal collection

TABLE 2

Analysis of mammal remains from Shelter 6, Fromm's Landing, showing numbers of individuals of each species at each level. Figures in parenthesis are based on identifications of limb bones.

C14 estimations: B.C.								1000±91			1220±94				1500±90				
Levels:	1	2	3	4	5	6	7	8	9	10	11	12	13	15	16	17	18	18B	Total for each species
DASYURIDAE																			
Myrmecobius fasciatus														1					1
PERAMELIDAE																			
Perameles bougainville	1	1	1		1	(2)													6
Chaeropus ecaudatus									1										1
Isoodon obesulus															1				1
PHALANGERIDAE																			
Trichosurus vulpecula	1	1	(1)		(1)				(1)	1	1	1			1			(1)	10
MACROPODIDAE																			
Bettongia penicillata		1		1	1	(1)		(1)	(1)	1		1			3	(1)	1	(1)	14
Lagorchestes leporides		1			2				1	1									5
Lagostrophus fasciatus																	1		1
Thylogale eugenii	1			1			1			1	1								5
Macropus canguru							1								1	1		(2)	5
MURIDAE																			
Hydromys chrysogaster						1	1		(1)							(1)		1	5
Rattus luterolus	6	4	4	4	7	1		1	2	3	2	1	(1)		1			(1)	38
Rattus greyii										1		1	1					(1)	4
CANIDAE																			
Canis familiaris dingo										1									1
Total for each level:	9	8	6	6	12	5	3	2	7	9	4	4	2	1	7	3	2	7	97

from Shelter 2. This greatly modifies the picture published previously, in that 4 species (*Wallabia rufogrisea, Thylogale billardieri, Potorous tridactylus* and *Phascogale*) are now omitted, 11 additional genera are listed, and adjustments have been made to grouping at most levels.

Hale and Tindale (1930) listed mammal sub-fossils, which had been identified by H. H. Finlayson, from the Devon Downs shelter. In this case, a reasonably accurate picture was presented of the mammals of the site. However, the material contains also a specimen of *Dasycercus*, one of *Thylacinus*, 2 of *Onychogalea* and about 10 of *Lagostrophus*.

Identification of Specimens

Antechinus flavipes: Although jawbones of this species are almost identical with those of *Phascogale calura*, the shape of the angle of the dentary identifies the specimens from Shelter 2 as *A. flavipes*.

Sminthopsis cf. *murina*: The entries in Table 2 are based on dentaries which cannot be identified specifically. However, these resemble specimens of the *S. murina-S. leucopus* group rather than *S. crassicaudata*, and *S. murina* is known to occur in the Murray scrubs area while *S. leucopus* favours a coastal habitat.

Dasyurinus geoffroyi: Jones (1923, p. 91, 93) indicates that this species is a larger animal than the *Dasyurus quoll* (= *viverrinus*) of South Australia. This is supported by a 'Murray R.' specimen of the former (N.M.V., No. R.1328) and sub-fossil series of the latter from W. Victoria. Size of the teeth of the specimens from shelter 2 show that they are of the larger form.

Isoodon obesulus: The several specimens from the Fromm's Landing sites demonstrate an animal considerably smaller than the W. Victorian form of this species.

Lasiorhinus latifrons: Finlayson identified this genus from the uppermost layer in the Devon Downs shelter, and it is extant along the Murray R. However, the fragmentary wombat specimens from Shelter 2 cannot be identified specifically and, therefore, may be partly or wholly of *Phascolomis mitchellii*.

Bettongia lesueur: Of the 2 specimens from Shelter 2, the one from Level 2 is of a much smaller form of the species than the one from Level 6.

Potorous morgani: The specimens from Shelter 2 are of the form which was described by this name by Finlayson (1938). This is also the identity of the 'Potorous' from Levels 1 and 6 of the Devon Downs Shelter. The question of the relationship of this form to *P. platyops* has not been considered in connection with the material from Shelter 2. (*Potorous tridactylus* has not been found in any of the 3 Murray R. shelters.)

Macropus canguru (= *major*): A number of the excavated specimens could be identified as *M. canguru*, but none was specifically identifiable as *M. rufus*. Therefore, although some fragments may be of the latter, all have been counted as *M. canguru*.

Psuedomys, Thetomys, Notomys: The fragments available are not sufficient for specific identification.

Distribution Data

Antechinus swainsonii: A typical dentary was in Level 1 of Shelter 2. The species has not been recorded previously, either living or fossil, for South Australia.

Dasycercus cristicauda: There was one dentary in Level 1 at the Devon Downs shelter and another in Level 7 at Shelter 2. The species is a desert animal and it has not previously been recorded from S. South Australia.

TABLE 3

Analysis of mammal remains from Shelter 2, Fromm's Landing, showing numbers of individuals of each species at each level

C14 estimations: B.C.					1290±80		1806±85		1931±85	2105±85	2900±100		Total for each species
Levels:	0	1	2	3	4	5	6	7	8	9	10	11	
DASYURIDAE													
Antechinus flavipes	5			1				1					7
Antechinus swainsonii		1											1
Dasycercus cristicauda								1					1
Sminthopsis cf. *murina*			1	1									2
Dasyurinus geoffroyi						1	1						2
Dasyurops maculatus					1	1					1		3
Sarcophilus harrisii						1		1					2
Myrmecobius fasciatus									1				1
Thylacinus Sp.								1					1
PERAMELIDAE													
Perameles bougainville	5		4	2		1	2	3	2	2			21
Chaeropus ecaudatus	2		1										3
cf. *Isoodon obesulus*	2		1				1	1					5
PHALANGERIDAE													
Pseudocheirus peregrinus	1	1	2										4
Trichosurus vulpecula	10	3	1	2									16
PHASCOLOMIDAE													
cf. *Lasiorhinus latifrons*	1						1	1	1		1		5
MACROPODIDAE													
Bettongia penicillata	14	2	2	4		2	24	16	4	2	1		71
Bettongia lesueur			1				1						2
Potorous morgani							2	2					4
Lagorchestes leporides	9	1	1	3	1	3	11	5	3		1		38
Lagostrophus fasciatus	8		2	2	2	4	20	11	3	1		1	54
Onychogalea lunata	1												1
Thylogale eugenii	3	1	2	2		2	2	3	1				16
Macropus canguru	2			3	1	3	4	3	1	1	1	1	20
MURIDAE													
Hydromys chrysogaster	2	1				2	1	1					7
Rattus lutreolus	138	13	20	32	2	25	15	17	7	6	2	1	278
Rattus greyii	6		1	5		1							13
cf. *Pseudomys auritus*	1			1								1	3
Thetomys sp.				1									1
cf. *Notomys*			1	1									2
Conilurus albipes	1	1				1							3
CANIDAE													
Canis familiaris dingo	1												1
Total for each level:	212	24	40	60	7	47	85	67	23	12	7	4	588

Sarcophilus harrisii: Special comment was madc (Mulvaney 1960, p. 68, 81) on a single specimen of Tasmanian Devil, at Level 7, in Shelter 2. However, thcre was a second fragment of the species from Levcl 5. The prcsence of *Sarcophilus* at these levels demonstrates its occurrence in the locality betwen about 1900 B.C. and 1300 B.C. Judging by the date given by Tindale (1957) for Layer 9 of the Devon Downs Shelter (2300 ± 180 B.C.), the Dcvil had about the same time distribution in this site also.

Thylacinus sp. (Tasmanian Tiger): See Appendix 3. Its occurrence in Level 7 was contemporary with *Sarcophilus*.

Pseudocheirus peregrinus (= *laniginosus*): The species occurred only at the 3 upper levels in Shelter 2, and was not at Level 7 as reported in the 1960 paper. Similarly, in the Devon Downs shelter, it did not occur below Level 4. This indicates a time distribution of the species, for thc general area, from about 1300 B.C. to the present.

Lagorchestes leporides: This was prcsent at almost all levels in Shelter 2, not only at Level 7 as was indicated in thc 1960 paper.

Lagostrophus fasciatus: This species also was represented at almost all levels in Shelter 2, not only at Level 6 as was reported in 1960. Furthermore, therc are specimens of it from Levcls 2, 4, 6, 7, 8, 10 and 11 in the Devon Downs shelter. Gould (1849, Pl. LVI) quoted an early rcport that it was frequently met with near the Murray R., but this was discredited by both Jones (1924) and Troughton (1941). The specimens from the shelters now vindicate Gould's report.

Onychogalea lunata: As well as the surface occurrence in Shelter 2, there are specimens of *O. lunata* from Layers 6 and 7 in thc Devon Downs shelter.

Discussion

The mammals of the Devon Downs and Fromm's Landing shelters represent an essentially modern fauna, and this shows no major variation in composition during the time of accumulation—approximately 5,000 years. There is no evidence from these sites of any of the extinct giant marsupials of the Upper Pleistocene. Gill (1955) gave evidence that a comparatively arid period occurred in Australia, between 6,000 and 4,000 years ago. If such a pcriod did produce conditions responsible for extinction of large Pleistocene marsupials, the lowest levels of the 3 archaeological excavations presumably post-date that period.

Competition from the dingo may have contributed to the dying-out of *Sarcophilus* and *Thylocinus* on the Australian mainland. Concentrations of mammal remains at the middle levels of both the Devon Downs shelter and Shelter 2 may indicate a pcriod of more vigorous vegetation. Some significance may bc attachable to the restriction of *Pseudocheirus* to upper levels. More excavations are nceded to help clarify points such as these.

Appendix 2

A 3,000 YEARS OLD DINGO FROM SHELTER 6

By N. W. G. MACINTOSH

DATA RECEIVED FROM D. J. MULVANEY

'The discovery of the skeleton of a dingo was made during the 1960 season. It was enclosed within Layer 10, and most probably became buried fairly early in Layer 10 times. It was uncovered near the S. wall of the trench, at a depth from the surface of 5′ 9″ to 6′ 3″, and 3′ 6″ out from the rear wall of the shelter at that depth. This area was completely covered by the rock overhang, and was set back too far in the shelter to have been reached by the prehistoric flood of about the same period.'

'The remains covered an area approximately 11″ by 13″. The layer in this area consisted of the hard grey "ashy" concretion, and the bones were underlain directly by an horizon of black ash and small charcoals. The skeleton was partially excavated, and upon identification, it was encased in paraffin wax and removed in a block.'

'The age of the animal can be estimated. (NPL 28), 1000 ± 91 B.C., was collected in Layer 8, 4′ 6″ below the surface; (NPL 29), 1220 ± 94 B.C., consisted of wood charcoal from Layer 11, 7′ from the surface and only 9″ below the dingo. An age intermediate between these dates is therefore indicated. It is therefore the oldest fossil dingo to be dated in Australia, although it is several thousand years later than the earliest domesticated dog in the Old World.'

The Specimen

As received, it consisted of a compacted mass of gritty sand measuring 33 × 27 × 13 cm (Pl. LXXIII A). One side of the mass, presumably the lower or base, was flat; the opposite side, presumably the top, was more convex. It contained a dingo skeleton; visible on the upper surface were the thigh bones flexed at the hip joints, the knee joints semi-flexed, the vertebral column uniformly convex, and the right side of the skull. The epiphyseal junctions of femur and tibia were not united and indicated an immature animal.

Technique

One planned to remove the individual bones in sequence, in the hope that relationships of adjacent bones had not been disturbed within the mass and so identification and reassembly would be easier. Also posture at death and related events at the locus might therefrom be deduced. Successive photographs recorded the stages of removal of the skeleton from the matrix.

It was found that the paraffin which had been applied to the block had penetrated the sand and formed a soft cement, instead of merely providing a coating. Xylol removal proved ineffective and the bones were recovered by dissection with fine blade scalpel and needle-point forceps, the paraffin cement being pared away in wafers. Mr Burton Bailey shared equally with the writer the extraction from the matrix, identification, reassembly and mounting of the skeletal material (Pl. LXXII).

All sand and grit (Munsell 10YR 5/4) was preserved and sieved. Some 40 pieces of shell and some 30 chips of charcoal were observed, no fragment of either being more than 0·5 cm in any dimension. 3 tiny avian bones and some minute spicules (unidentified) were present. No missile, no stone or bone implement, not so much as a flake or chip of stone occurs with the remains.

Posture

The thoracic and lumbar vertebral column was uniformly flexed; the cervical column was also flexed and turned through an angle of about 150° to the left, so that the left and lower aspects of the skull were lying on and concealing the left scapula and humerus. The jaws were completely closed, the teeth interlocked. The forelimb bones were completely flexed at the shoulder and elbow joints. The penultimate 4 caudal vertebrae were lying ventral to the last 2 or 3 lumbar vertebrae, so the tail had either been tucked in between the hind legs or over the left hind quarter. Apparently the animal died lying right side down and curled up into a ball.

Missing Bones

Left tympanic bulla; 1st right rib; chevrons; coccygeal vertebrae 1-3, 6-12, 17-18; 3 left carpals, 4 right tarsals; phalanges—8 proximals, 8 middles, 9 distals; sesamoids—1 gastrocnemial, 2 popliteal, 9 volar; left lower 2nd molar tooth. The skeleton is therefore extraordinarily complete, even down to minute bones; which makes the absence of ⅔ of the tail bones very surprising.

Damaged Bones

Posterior 2 × 1 cm of external surface of body of left mandible missing and adjacent bone fractured; facial and palatal sutures sprung; gap, 1 cm diameter, in left scapular infraspinous fossa; gap, 1 × 4 cm, right scapular serratus area; spines T3, T4 and T9 fractured, right ribs 3, 5 and 9 fractured. All these are post-mortem and very recent; they must have occurred during excavation or subsequently.

Relationship of Bones

Only 2 vertebral bodies (both thoracic) were found to be separated from their arches, but not a single upper or lower epiphyseal plate was fused with its vertebral body. About 70% were in correct position of contact, but the remaining 30% were scattered out of contact and had to be individually selected and matched for fit, and then glued to the bodies. Diaphyses and epiphyses of the limb bones were separated but had not been grossly displaced. Relationships of the ribs presented a little difficulty; they had been compressed upon themselves antero-posteriorly and also bilaterally; hence some left ribs had been inserted between rights and vice versa and the sequence of 1 to 13 antero-posteriorly had not been maintained, overlapping displacement having occurred. This meant that each rib had to be identified by anatomical minutiae for the purpose of reassembling the skeleton. One visualizes, therefore, slow and slight but progressively increasing earth pressure uniformly distributed from above and around the perimeter of the animal compressing it upon itself and against an already compacted floor. Apparently from the moment of its death until the intrusion of the archaeologist, the animal had remained undisturbed, save for the question of its tail.

As the archaeologist so successfully recovered minutiae such as volar sesamoids and terminal phalanges and fragile bones such as the hyoid greater and lesser cornua, it seems unlikely that he would simply have failed to recover 12 coccygeal vertebrae, although there is the fact that the right 1st rib and the lower left 2nd molar are missing also. Assuming the missing vertebrae were not lost at excavation, the curious distribution of the missing vertebrae needs to be observed. There are usually 18 coccygeal vertebrae in the dingo, domestic dogs exhibiting 17 to 23. The terminal one or two, i.e. the 17th and 18th coccygeal, vertebrae in the dingo are usually extremely small and would most likely go missing at excavation. It has already been noted that the 13th-16th were lying ventral to the lumbar vertebrae, indicating the end of the tail was tucked in against the abdominal wall and so sheltered. A predator, such as a rat, might conceivably have gnawed through the proximal and middle sections of the tail; this speculation (by a member of a Sydney University symposium audience, 5-7 October 1963) seems possible. *Rattus* occurs at practically all levels in the Lower Murray Valley excavations. Of a considerable number of other suggestions advanced, the most popular was that aborigines ate the tail; this is extremely unlikely; firstly, the terminal part of the tail would also have been missing and, secondly, an immature, or even an adult dingo's tail is almost totally devoid of meat.

Condition of the Bones

They have a firm dry appearance and, with careful handling, are not particularly brittle, but will fracture in a dry-stick fashion under mild pressure; at the same time, they are not friable and exhibit no surface corrosion or erosion. At the sites of the fractures already referred to, the cancellous bone and trabecular structure show no evidence of disintegration. The bones show no trace of fire or smoke and there is no differential colouration; they are uniformly of the same hue (Munsell 7·5YR 6/6). Every tooth shows multiple fissure cracks in the enamel. They occur most prominently on the basal aspects of the crowns and run parallel in a cervico-occlusal direction or present a cross-hatched intersection pattern. Ferruginous stain has invaded the enamel via these fissures. Had the skeleton been presented out of context, there would have been no reason apart from the teeth to advocate antiquity since, to the naked eye, it presents no patina, mineralization, or incrustation. Various writers, e.g. Wood Jones (1934), in arguing against the antiquity of the mineralized Cohuna and Talgai skulls, have referred to rapid mineralization in Australia, instancing mineralization of bones of the introduced horse. The present specimen indicates that, for some regions, absence of mineralization is compatible with considerable antiquity.

Cause of Death

There is absolutely no evidence of pre-mortem damage to the skeleton. Trauma by a blow sufficient to cause death would have fractured some bone and none is so fractured. Even death by a spear thrust might be expected to cause damage to the rib cage and such is not present. Very obviously it was not killed by the aborigines for food.

All its bones are well modelled, its teeth are well formed and the arrangement of its dental arches is completely normal. Attritional wear is present on every tooth, but it can only be classified as mild.

Neuro-muscular poisons cause death in opisthotonus, i.e. extension, not flexion; of course, as rigor mortis is not instantaneous, the ultimate position would be relaxed semi-extension.

It is most probable that the animal went to sleep in the normal curled up position assumed by *Canidae* in cold weather and simply died in its sleep.

Ethnological Deductions

There is no justification for assuming that the rock shelter was being used by aborigines, either as kitchen, workshop, or shelter, or that they were even in the vicinity at the moment of death of this dingo. By elementary rule of thumb, every vertical inch of deposit at this site may represent a time span of 40 years. Mulvaney (1960 and the present report) has shown clearly that occupational debris occurs intermittently, aboriginal utilization of the sites was not continuous, not uninterrupted. He has also rightly emphasized that 'cultural material was sparse throughout' (1960, p. 73).

Evidence is against the presence of aborigines at the time of death of the dingo. It has already been stated that only 40 chips of shell and 30 chips of charcoal were recovered from the matrix (Munsell 10YR 5/4) containing the skeleton, i.e. less than 0·00001% of the cubic volume. This contrasts dramatically with the underlying horizon of black ash and small charcoals. These few shells and charcoal chips must be assumed to have drifted from adjacent horizons rather than to have been the products of contemporary occupation. The absence of any fire evidence on the bones and, indeed, the absence of any disturbance to the anatomical skeletal relationships (except the mid-proximal section of the tail) reinforces this view.

To assume, therefore, that this dingo is evidence of even symbiotic relationship, let alone domesticity, with the aborigines at that period cannot be justified. It is to be hoped there will not be more read into the occurrence of this dingo than the evidence admits.

Sex

Presence of the os penis saved necessity of any analysis to determine sex.

Individual Age

Complete eruption of the permanent dentition has occurred (Pl. LXXIII B). Left lower M_2 had fallen out of its socket and was not recovered at excavation. All other teeth are present. The pattern of eruption time of dingo dentition is approximately the same as for domestic dogs. Sisson (1945) says M_3 erupts by the 6th to 7th months. On each side of the present mandible is a fully erupted and perfectly modelled M_3. It is true that process of eruption is rapid in the *Canidae*, but buccomesial wear polishing can be observed when these 3rd molars are examined under a dissecting microscope, indicating that they had been functional.

It is necessary to digress briefly. Presence of lower 3rd molar is one of the criteria aligning the dingo with wolves, domestic dogs, and jackals and separating it from the Indian red dog or dhole (Genus *Cyon* or *Cuon*), in which, incidentally the 2nd molars are relatively smaller. The validity of this 3rd molar criterion has been variously discussed by Hodgson, Cope, Lund, Huxley, Mivart, Lydekker, Wood Jones, and others. Longman (1928) referred to some of this discussion and instanced anomalies. He also remarked on the absence of wear on this tooth and quoted and apparently supported Lönnberg's version that it is a small useless tooth having no antagonist to work against. It is sufficient to remark here that attritional wear is not confined to teeth which make contact occlusion with one another. The crowns of 1st, 2nd and 3rd upper and lower premolars, in dingo, and domestic dog, do not make contact in occlusion, but nevertheless exhibit attritional wear. In this present specimen, attritional facets are most pronounced on lower 1st molar followed by lower 3rd incisor as one would expect, but no tooth is totally free from any attritional evidence. It is deduced, therefore, that the total permanent dentition had been functional for at least a brief period, suggesting the animal could have been 7 months old at death.

A second digression is appropriate at this moment and necessary with reference to the 1st upper molars. Wood Jones (1921, 257; 1925, 354) stated the continuous cingulum of this tooth as seen in jackals and foxes, 'is reduced or wanting in the middle of its length' (labially) in wolves. He claimed that similar condition in domestic dogs and dingo indicated their true wolf affinity. In the Fromm's specimen the gingulum is not 'wanting'; it is continuous and uninterrupted (Pl. LXXIII B). The term 'reduced' is a subjective one. In the comparisons I have made so far, I would not call it reduced. Before being dogmatic about it, it needs to be compared with a larger series of jackals and foxes. Wood Jones's claim about this cingulum has previously been challenged by Tate (1952). It is morphological features of this sort that make the attested archaeological specimen so valuable.

Time patterns of epiphyseal closure, as observed in a colony of dingoes bred at this Department, University of Sydney, differ from those of domestic dogs as quoted in literature, e.g. Sisson (1945).

In this specimen, no union whatever has occurred at the proximal or distal ends of humerus, radius, ulna, femur, tibia, fibula; hence, if dingo pattern matched the literature about domestic dogs, the age of this specimen at death would be some age less than 6 months.

However, the proximal ends of the metatarsals of the forelimb are almost completely fused and of hindlimb completely; their distal ends are not fused. The proximal ends of the forelimb proximal phalanges are fused with the shaft, but in the hindlimb they are not. The distal ends are almost completely fused in forelimb and completely fused in the hindlimb. Judged by comparison with domestic dogs, this animal would be very slightly under 6 months in age.

Union of the tuber scapulare does not occur in domestic dogs before 6 to 8 months. In this specimen, union is present on the lateral (dorsal) aspect. This would indicate an age of perhaps 7 months for the animal under examination. However, this is offset by our observations that the tuber scapulare, the olecranon process, the tuber calcis, and the distal ends of radius and ulna unite appreciably earlier in the dingo than the times indicated for domestic dogs. In the specimen under examination, the 3 parts of the innominate bone are fused at the acetabulum, the iliac crests and the ischial tuberosities are firmly positioned, but the inferior ischial and pubic rami are separated by 0·18 mm, and the pubic bodies by 0·21 mm. This indicates an age slightly above 6 months and a somewhat different pattern of closure from that of the domestic dog. Summarizing the total evidence, the age of this animal at death was pproximtely 23 to 27 weeks.

Size Relative to Age

Table 4 compares measurements of the Fromm's Landing 6-months-old dingo with a 4-months (No. 9) and with a 9½-months (No. 32) old dingo each bred in the Department of Anatomy, and with dingo figures quoted by Mivart. He nominated length of vertebral column as 100% and expressed all other measurements absolutely and also as percentages of the vertebral column length. This method has been used here. The relative proportions agree rather closely in all 4 columns.

The Fromm's Landing animal is absolutely small for its age of 6 months, being smaller in all dimensions than the 4-months-old dingo (No. 9). Its skull, while being absolutely smaller, is slightly larger relative to its body and limb dimensions than is the case in the Sydney animals and in Mivart's item.

Mivart's comparative table (1890-*q.v.*) for various *Canidae* indicates that the Fromm's Landing animal and the two Sydney dingoes match only the proportions for dingo. (Their nearest similarity otherwise in Mivart's table is to *C. latrans*, but they show some significant differences from it also.)

Size Relative to Modern Dingo

Tables 5 and 6 show that the teeth of the animal from Fromm's Landing lie within the size range for those of the modern dingo, and that the relative size of the teeth to one another are of a similar order. A criterion identifying certain ferals (including dingo) from other groups of *Canidae* is the observation that the mesio-distal diameter of the upper 4th premolar is about the same as the diameter from mesial aspect 1st molar to distal aspect 2nd molar and also approximates to 10% or more of the basilar length.

The occurrence of a small thylacine tooth (Appendix 3) at adjoining Shelter 2, with an antiquity of almost 4,000 years, and a small dingo with an antiquity of 3,000 years, is a coincidence which perhaps needs the comment that one is not justified in speculating that the region was *per se* producing dwarf types.

TABLE 4

	Dingo from Fromm's Landing		Bred in Dept Anatomy, U. of S. No. 9		Bred in Dept Anatomy, U. of S. No. 32		Mivart (1890)	
	male aged 6 months		male aged 4 months		male aged 9½ months		— adult	
	cm	%	cm	%	cm	%	cm	%
Vertebral column from front of atlas to hind end of sacrum	47·0*	100	55·0	100	70·0	100	63·5	100
Cervical vertebrae ..	11·9*	25·3	—	—	—	—	16·0	25·2
Thoracic vertebrae ..	17·5*	37·2	—	—	—	—	24·0	37·8
Lumbar vertebrae ..	14·5*	30·9	—	—	—	—	18·5	29·1
Sacrum ..	3·1	6·6	—	—	—	—	5·0	7·9
Height at T3 ..	34·0	72·3	39·2	71·3	49·5	70·7	—	—
Humerus	12·1	25·7	12·8	23·3	17·3	24·7	16·5	26·0
Radius	12·0	25·5	13·0	23·6	17·0	24·3	16·0	25·2
Ulna	14·1	30·0	15·3	27·8	20·1	28·7	—	—
Index metacarpal ..	4·7	10·0	5·4	9·8	6·3	9·0	5·7	9·0
3rd metacarpal ..	5·3	11·3	6·3	11·5	6·8	9·7	6·4	10·1
Femur	13·4	28·5	14·3	26·0	18·5	26·4	18·0	28·3
Tibia	12·8	27·2	13·6	24·7	18·4	26·3	17·6	27·7
2nd metatarsal ..	5·2	11·1	6·0	10·9	6·6	9·4	6·3	9·9
3rd metatarsal ..	5·8	12·3	6·7	12·2	7·4	10·6	—	—
Basion to sphenoideum	3·97	8·4	—	—	—	—	5·1	8·0
Sphenoideum to ant. edge of premaxilla	10·27	21·85	—	—	—	—	13·2	20·8
Sisson's Breadth/Length Index: Skull (nuchal crest to ant. end of premaxillary suture) ..	15·6	33·2	15·9	28·9	20·4	29·1	—	—
Max. bizygomatic ..	7·7	16·4	8·2	14·9	10·3	14·7	—	—
Skull index	49·4		51·6		50·5			
	(all at the extreme range of dolichocephaly)							

* Calculated, making allowance for intervertebral discs: +0·7 cervical,
+2·0 thoracic,
+1·3 lumbar,

Total: = +4·0 cm.

It has been noted that size is normal for the teeth of the dingo, it is only its skeletal framework which is small. It was our experience in breeding a colony of dingoes that, during the juvenile stages, size of animal was closely related to amount of food consumed. One may be justified in speculating that food supply was not over abundant at Fromm's Landing or perhaps that this particular dingo lacked efficiency.

TABLE 5

Mesio-distal lengths in mm of	Dingo from Fromm's Landing	Dingo No. 32 Sydney	Mivart's largest of 5	Mivart's smallest of 5
P^1	5·55	5·20	6	5
P^2	10·60	10·00	12	10
P^3	11·65	11·35	13	11
P^4	19·35	18·48	21	18
M^1	12·85	12·25	15	12
M^2	7·10	6·78	8	7
P_1	4·15	3·84	5	4
P_2	8·16	8·12	10	8
P_3	10·40	9·50	11	10
P_4	11·12	10·64	12	11
M_1	21·00	20·20	23	20
M_2	9·36	9·00	10	9
M_3	5·02	5·20	5	5

TABLE 6

Mesio-distal lengths in mm of	Fromm's Landing Dingo	Dingo No. 32 Sydney	Tichota 1937 3 samples	Wood Jones 1921 22 samples	Longman 1928. Av. of 10 samples	Tate 1952 6 samples
Mesial of M^1 to distal of M^2 ..	20·05	18·98	19–21	—	—	—
P^4	19·35	18·48	19–21	19·5–22·0 Av. 20	20	18·0–19·0 ♂ 17·6–20·3 ♀
Basilar length	140	178	170–170	165–193 Av. 177·3	181	178–184 ♂ 163–195 ♀

Comparative Fossil Material

McCoy (1882, Pl. 61) illustrated *Canis* teeth from Mt Macedon (Gisborne) cave and from L. Colongulae in Victoria. Etheridge (1916, Pl. 10-12) illustrated 3 of 7 *Canis* teeth from the Wellington Caves, N.S.W., which included those earlier written about by Krefft (1865). Fossil remains of extinct mainland marsupials were recovered from these sites. Gregory (1906) observed similar association at L. Eyre. Those 4 authors thought the association indicated contemporaneity and an antiquity for the dingo of early post-Tertiary time. Present opinion is that, while the fossil dingo and fossil marsupial remains may have been contemporary, proof has not been shown, as the deposits at Gisborne and Wellington cannot be stratigraphically identified.

McCoy (1882, 7) said the left mandibular fragment with 1st molar from Colongulae was slightly but 'perceptibly more robust than the modern variety'; yet two pages subsequently he said 'I find, on the most minute comparison and measurements, no difference between the fossil and the recent individuals. . .'; he said the Gisborne dingo remains agree very closely with the living dingo. Etheridge (1916, 50) said the Wellington Caves specimens were 'of a dog somewhat superior in size to the Warrigal'.

I thank John McNally, Director, and Edmund D. Gill, Curator of Fossils, National Museum of Victoria, for the loan of dingo specimens. This collection includes the items described and figured by McCoy. Gill (pers. comm.) observed from Flourine Phosphate Indices, that the Colongulac dingo is younger than a female aboriginal skeleton found there, but older than European advent. The enamel of the Colongulac dingo lower left 1st molar is cracked and mottled brown and, in this regard, appears to be intermediate in appearance between the older thylacine tooth and the younger dingo teeth from Fromm's Landing. While this probably indicates that the Colongulac tooth has some antiquity, it is not suggested that relative dating of items from different sites can be hazarded on such subjective observations; also Gabriel (1948) pointed out that there is individual variability in suceptibility to enamel cracking and staining.

McCoy gave measurements for the Colongulac and Gisborne teeth in inches and lines. I have remeasured these with vernier mm calipers. The Colongulac left lower 1st molar is 23·1 mm mesiodistal and 9·78 mm labio-lingual. The mesio-distal diameters of the Gisborne teeth are upper right P^2 10·7, P^3 11·9, P^4 17·83, M^1 10·88 mm. Etheridge said the lower right M_1 from Wellington measured 21 mm.

Mr F. D. McCarthy invited me to identify and comment on teeth fragments from Site 3, Layer D, Section 6, depth 19 to 24 in., Bondaian phase of the Eastern Regional Sequence, at his Glen Davis excavation. He still awaits results from carbon samples submitted for C-14 dating. They are *Canis* teeth, the majority broken into several fragments; after repair, some were complete enough to measure. Their identifications and mesio-distal diameters, where these could be measured, are as follows:

Upper left:	M^1, P^4 (19·5 mm), canine.
Upper right:	P^4 (19·5 mm), canine (10·0 mm), I^3 (7·2 mm).
Lower right:	M_1 (22·25 mm), P_4 (12·0 mm).
Lower left:	M_1.

They all come from a single animal which from the evidence of dental attrition was fully or post-mature; they are badly weathered; the enamel shows brown mottle stain but the fissure cracking seen in the Fromm's Landing and Colongulac teeth is minimal or absent. Black speckling is present which McCarthy says is a manganese effect. Under microscopy, these black patches look like deposit rather than stain. The labial cingulum on the upper 1st molars appears to be somewhat reduced. Further study on these teeth is proposed at a later date. These teeth are a useful addition here, to extend the limited series of fossil remains.

It can be observed that only the Colongulac tooth is at the extreme range of large size recorded for recent dingo teeth. All other specimens here examined are within the range.

Conclusion

Wood Jones (1925, 355-6) stressed the degree of uniformity of skull type in the dingo and refuted the popular belief that dingoes are so freely crossed by station dogs that a thoroughbred dingo is hard to come by. Tichota (1937) further stressed the uniformity of skull type and Macintosh (1956) also rejected the popular belief about hybridization. Mulvaney's archaeological find substantiates these views and proves that dingo morphological pattern has remained constant for 3,000 years. As the oldest genuinely dated dingo, it establishes the pattern type of the dingo. Its total and detailed anatomy, therefore, should be put on record; time and space have not permitted that in this present report and only controversial facets have been pursued. One hopes to make fuller description subsequently.

SUMMARY

This adolescent male dingo from Mulvaney's excavation at Fromm's Landing, South Australia was 23 to 27 weeks old at death.

Save for the 1st rib, the lower left 2nd molar tooth and the middle and proximal portions of tail, the skeleton is substantially complete and undamaged. There is no evidence of pre-mortem trauma or cause of death. Apart from staining and cracking of tooth enamel, there is no gross evidence of antiquity, such as patination, or mineral incrustation.

The evidence suggests that the animal died curled up on its right side in sleep and remained undisturbed until the arrival of the archaeologist. It is speculated that a predator such as *Rattus* might have been responsible for the portion of tail being absent. There is no evidence that this animal was in symbiotic or domestic association with the aborigines, rather the evidence favours that it had taken refuge in the shelter during an hiatus in aboriginal occupancy.

Its skeletal frame is absolutely small for its age when compared with modern dingoes; its skeletal indices coincide with those for dingo in the classificatory literature and differentiate it from other *Canidae*. Its teeth are indistinguishable from and are within the size range of modern dingoes and of available comparative fossil dingo specimens. It is suggested its small size may be related to poverty of food supply.

This relic proves that dingo morphological pattern has remained unchanged for 3,000 years. As the oldest genuinely dated dingo, this animal establishes the type of the dingo. It is hoped, therefore, to put on record subsequently its total and detailed anatomy.

Appendix 3

A 4,000 YEARS OLD THYLACINE TOOTH (DASYURIDAE) FROM SHELTER 2

By N. W. G. Macintosh and J. A. Mahoney

This tooth from Layer 7 at Shelter 2 was sent to me (NWGM) for confirmation or denial of a tentative diagnosis reading 'cf. *Canis familiaris* dingo'. It was obviously not a dingo permanent tooth and subsequent comparison with dingo deciduous dentition established that it was not dingo. The C14 age of Layer 7 is intermediate between 1806 ± 85 B.C. and 1931 ± 85 B.C.

Basically it has the pattern of a carnivorous permanent upper left 1st molar or deciduous last premolar and its essential morphological pattern is thylacine (Pl. LXXIV). However, its crown size is small, 8·90 × 6·26 mm; its roots are stained blackish brown and in contrast with the lighter coloured crown give a subjective impression of excessive gracility; while having the basic pattern of a thylacine upper left 1st molar in miniature, there is, 'apparently or superficially', total absence of definitive buccal styles and an aberrant looking protocone. First impression, therefore, suggested that the tooth was from a dwarf thylacine. A summary of the firm conclusions of Flower (1868), Bensley (1903), Todd (1918), Jones (1923), and others, is to the effect that in no marsupial is there more than one tooth, bilaterally in upper and lower dentition, replaced by a succeeding tooth. Replacement, when it occurs, involves the last premolar. The deciduous tooth is molariform, and so, unlike its successor and, furthermore, the deciduous tooth is vestigial in *Thylacinus*. Hence, any notion that the tooth could be deciduous is excluded.

A thylacine-like tooth from an apparently irrefutable archaeological context and attested by C14 dating as having such low antiquity on the mainland as about 4,000 years, is so important to so many facets of Australian archaeology as a whole, that it calls for thorough attention. Therefore, I invited Mr J. A. Mahoney, who has examined dasyurid material in another context, to direct me to sources of comparative material and to take part with me in the identification of the tooth. From that point, the present paper becomes one of co-equal investigation, authorship, and responsibility. We thank colleagues A. C. Gabriel DDSc., and B. C. W. Barker MDS, FDSRCS, of this Department of Anatomy for consultations and for checking our progressive observations.

Material used for comparison consisted of 18 skulls of *Thylacinus cynocephalus*, 14 in the Australian Museum; 3 in the Macleay Museum, University of Sydney; 1 in the Department of Anatomy, University of Sydney; and 6 left and 4 right fossil upper 1st molars (Australian Museum No. F50818-27) from the Wellington Caves, N.S.W.; such latter specimens have been nominated generally as *T. spelaeus*; they were observed by us to be morphologically similar to *T. cynocephalus*, although attrition restricts total comparison and the mean size of 11·9 × 8·8 mm for the left molars (F50818-23) is larger than that tabulated for *T. cynocephalus* (*v.i*); detailed comparison in this paper has been based on and limited to *T. cynocephalus*; dasyurine (*Sarcophilus*, etc.) teeth were compared at the initial stage of the examination.

We thank Dr J. Evans, Director of the Australian Museum, and Miss J. Morris, Curator of the Macleay Museum, for access to this material.

Nomenclature used by us follows that employed by Bensley (1903) and illustrated in his Fig. 1, p. 89, which designates the adult upper molariform teeth in marsupial polyprotodont forms as 1st, 2nd, 3rd, and 4th true molars; buccal styles are designated alphabetically a, b, c1, c, c2 in order mesio-distally.

Description

The biting surface is triangular in outline; the metaconal tip is almost centrally placed in relation to buccal, palatal, mesial and distal enamel margins. The greatest diameter, measuring 9·40 mm, is a diagonal from mesio-palatal surface of protocone to distal surface of metaconal spur. The mesio-distal axis from mesial surface of paracone to distal surface of metaconal spur is 8·90 mm, and regarded by us as length of the tooth. With one caliper blade touching mesial aspect of protocone and paracone, and the other caliper blade touching distal aspect of metaconal spur, the diameter reads 8·92 mm. The greatest transverse diameter between buccal aspect of paracone and palatal aspect of protocone is 6·40 mm. Diameter between the surfaces of paracone and protocone when measured orthogonally, i.e. at right angles to the plane of the buccal surface of the entire tooth, is 6·26 mm and this is regarded by us as breadth of the tooth. In other words, the tooth fits into a geometrical figure which is approximately a right-angled triangle, of which the hypotenuse tangential to protocone and metaconal spur is longest, the base tangential to buccal aspect of paracone and metaconal spur is intermediate in length, and the remaining side tangential to protocone and paracone is the shortest. For absolute precision, it is noted that the angle subtended opposite the hypotenuse is 86° not 90°.

The enamel margin at the base of the crown is uniform and practically horizontal when viewed from palatal and buccal aspects of the metacone and its spur, but is undulant at the base of protocone and paracone. A cingulum-like prominence of the enamel continues as a shelf without interruption right round the perimeter of the crown; it is prominent on the buccal aspect, but least evident on the palatal aspect of the metacone, and is most pronounced palatally between metacone and protocone, forming an actual bridging platform at the base of the cleft between them.

The crown bears a bucco-mesial paracone, a palato-mesial complex protocone, and a distal metacone from the posterior border of which extends a trenchant spur or blade which shears against (presumably) the mesio-buccal border and slope of the triangular pillar of a more distal lower second molar. The shearing edge is relatively long and its disposition mesio-distal, but curved, presenting a buccal concavity. From the perimeter of the metaconal summit to the distal end of the tooth, the crest of the metaconal spur measures 4·25 mm. The tips of all cusps are of a piercing type. At their bases they are conical or vaguely triangular in cross section.

Bensley describes the thylacine metaconal tip as lanceolate from a filling out of the cavity originally present on its outer side. By lanceolate, presumably, he meant two-edged and symmetrical and this is well exemplified in this specimen. One edge is a sharp ridge running from the metaconal tip mesially and slightly buccally to the cleft between metacone and paracone, which it bridges and continues up on to the paraconal tip. The other edge runs from the metaconal tip distally and slightly palatally to become continuous with the crest of the metaconal spur; obviously a cutting or shearing edge, it is heavily worn by attrition in this specimen. Presumably it had originally a sharp edge; wear has flattened the edge which has transverse dimension of 0·45 mm mesially, tapering to 0·3 mm distally, exposing secondary dentine bounded by thin plates of enamel on either side. The enamel measures 0·16 to 0·25 mm in thickness. The two edges described lie almost in the same mesio-distal line and divide the metaconal tip into buccal and palatal hemicones; near the base of the latter is a faint ridge, which runs palatally and reaches the cleft between metacone and protocone. Cross section of the metaconal tip, therefore, is scarcely triangular, although a triangular trend can be said to be imposed on an otherwise circular cross section. The base of the metaconal tip is defined from the body of the crown by a faint almost perfectly circular groove.

The paraconal tip is defined at its base by a faint, more or less circular groove, interrupted by three edges. One of these, continuous with that from the metaconal tip, has already been described. Another extends from the paraconal tip bucco-mesially; it is sharp and continues on to the bulk of the paracone itself where it assumes a more directly mesial direction. The remaining ridge begins near the base of the paraconal tip, runs palato-mesially and continues to bridge the wide cleft between paracone and protocone and links with a ridge on one element of the protoconal tip. Hence, a cross section of paraconal tip has a more marked trend to triangular form than has the metaconal. The apex of the paraconal tip has been truncated by attrition rather more vigorously than the metaconal and more secondary dentine is exposed. The apex is not centrally placed relative to the total bulk of the paracone, but is excentrically displaced in a disto-palatal position with slight deviation of its tip in a buccal direction.

The protoconal summit is complex and, to the best of our present knowledge, unique in form. It is clearly divided into two definitive and unequal sized apices or tips. The smaller is entirely mesial in position and its long axis transversely disposed. The larger is entirely distal relative to the smaller and its long axis is mesio-distally disposed. They are separated by a well defined acute-angled cleft. Each tip has suffered attrition sufficient to remove the enamel and give linear exposure of secondary dentine, transversely in the smaller mesial apex, longitudinally in the larger disto-palatal apex. The base of the two apices combined is indicated by a faint horizontal groove situated at the junction of the cervical two thirds and the occlusal one third of the protoconal enamel. From this groove in a cervical direction there is complete continuity; bifidity only commences slightly more occlusally, but at once becomes pronounced. Continuity of enamel, at the angle of the cleft separating the two deviant elements, is interrupted by a fissure. The two apices excentrically surmount the protocone so that their bucco-distal surfaces are rather vertical while their palato-mesial surfaces are considerably sloped. A distal sharp edge or border occurs on the larger of the bifid elements.

All four apices are therefore clustered, as it were, about the occlusal fossa on the mesial moiety of the tooth. The shape of the fossa between paracone, metacone, and bifid protocone is influenced by the bifurcation of the protoconal apex. It is roughly diamond-shaped, bounded disto-buccally by the metaconal apex, buccally by the paracone, palatally by the larger distal element of the protocone, mesially in its palatal half by the smaller mesial element of the protocone and, in its buccal half, only by the ridge derived from the palatal aspect of the paracone and the buccal aspect of the protoconal smaller element. This fossa is deep and roomy. No attritional wear can be detected on its floor. No attritional wear occurs on the mesio-buccal aspect of the major protoconal element. A light attritional facet is present mesially and slightly buccally on the minor protoconal tip. An elongated attritional facet is present on the distopalatal aspect of the paraconal summit. This can only mean that the disto-buccal edge of the triangular pillar (presumably) of a more mesial lower 1st molar was of slightly different relative form and dimension in this animal than in the comparative material, or it was more adequately accommodated in this roomy fossa.

The undulant character of the enamel margin has been mentioned. Diameters taken vertically from the abraided tips of the metacone, paracone, larger protoconal element, and smaller protoconal element to the maximum convexity of the enamel margin, are as follows: metacone, buccal & palatal, 5·13 mm; paracone, buccal, 3·80 mm; larger protoconal element, palatal, 4·27 mm; smaller protoconal element, mesial, 3·15 mm. Metrically and morphologically, metacone is the most dominant part of the tooth, protocone is intermediate, and paracone least.

Buccal surface of crown: Bensley, in describing the reduced nature of buccal styles in thylacine teeth, says external paraconal styles are vestigial or wholly absent. But he refers to 'style ? ab' as apparently always present in the 1st, 2nd and 4th molars. He says style c is not represented, but a small element probably equivalent to c2 is apparently always present in the 1st molar, variable in the 2nd, scarcely distinguishable in the 3rd.

His term 'style ? ab' is very useful. In the majority of upper thylacine 1st molars examined by us, the elements a and b are clearly detectable as vertically disposed prominences of the enamel separated cervical-ward by a shallow gutter, but merging occlusal-ward, or alternatively terminating in separate blunt tubercles; such observation has not been recorded by Bensley or any other writer as far as we are aware.

In this present specimen, fusion of the two elements a and b is still more complete. The enamel between them demonstrates a flat surface on which is a barely perceptible groove. Occlusal-ward they fuse to form a vetigial style surmounted by a minute apex, adpressed to the mesio-buccal surface of the paracone and bounded mesially by a sharp edge. Distally, also, its tip is bounded by a sharp edge which quickly fades into a rounded border. Styles b1, c1 and c are each absent in the definitive sense, but their classical positions are occupied by small vertically elongated bulges, clearly evident in the case of b1 and c1, barely evident in the case of c. Style c2 is absent and its classical site occupied by a well defined uniform convex bulge. At the distal extremity of the metaconal spur crest on its buccal margin is a minute style. In shape and inclination (tilted mesio-palatally), it is similar in miniature to the classical style c2, but displaced to an extreme position distally.

The buccal surface lies only approximately in a continuously mesio-distal plane. The distal third of the buccal surface of the paracone presents a prominent convexity; the buccal surface of the metacone and its spur present two less prominent convexities separated by a very shallow groove running towards the distal border of the metaconal summit; while on the buccal aspect of the distal extremity of the spur, there is a shallow notch, which gives a subjective, but untrue, impression that the extremity is deviated buccally. A well defined but shallow cleft subtending an angle of 150° intervenes between paracone and metacone; there is no fissure in its floor. Diameters from the middle of this cleft to the mesial and distal ends of the tooth are 3·64 and 6·12 mm. The buccal surface, therefore, is appreciably undulant due to the bulges and grooves described.

Palatal surface of crown: The blade-like element of the tooth is more obviously expressed palatally and is accentuated by attritional wear. The uniform concave shallow fossa on the buccal aspect of the metaconal spur is replaced on the palatal aspect by a slight uniform convexity. Adjacent to the palatal edge of the metaconal apex and spur crest is a triangular attritional facet. It extends from the disto-palatal aspect of the tip of the metacone occluso-cervically over one half of the palatal enamel and is prolonged distally to the extremity of the spur crest. An elongated oval attritional facet occurs palato-distally on the larger (distal) of the bifid summits of the protocone. It extends from the abraded tip to about one third of the distance to the enamel margin and is parallel, but not adjacent, to the distal edge of the protocone. The palatal convexity and palatal displacement of the protocone away from the mesio-distal axis of the tooth accentuate the cone-like character of the protocone in contrast to the flat shearing blade-like character of the metaconal spur. A cleft intevenes palatally between protocone and metacone. Near the enamel margin it is shallow, being bridged by a definite shelf-like prolongation of the cingulum previously referred to. As the cleft runs occlusal-ward, it has a sigmoid curve, becomes deeper and more acutely angled. It is difficult to estimate the angle subtended and indeed it varies in different parts of its course. In the vicinity of the cingular shelf it is about 144°. No fissure occurs in its floor.

On the palatal aspect of the distal end of the metaconal spur is a rather large interproximal attritional facet caused by the upper second molar. Vertically it occupies almost two thirds of the surface. The enamel has been excavated in a gutter-like fashion and in the trough, a limited area is stained dark brown. The question of whether incipient caries is indicated, could only be solved by histological examination. A little mesial to this facet, there are two additional breaks in the enamel continuity; one is rather close to the palatal margin of the metaconal spur crest; the other, more deeply gouged and more darkly stained, is situated on the most prominent convexity of the cingular bulge. Five more blemishes occur on the protocone; of these, one is about half way up the middle third of the palatal aspect of the larger (distal) element of the protocone; it is sigmoid-shaped and deeply gouged through the enamel. Another is curvilinear palato-mesial in position close to the apex of this same protoconal element, but the enamel is merely stained, not gouged. Another occurs on the mesial aspect of the protoconal cingulum and presents a deep vertical gouge. Two similar more or less vertical gouges occur at the cervico-enamel junction of the buccal aspect of the metaconal spur. On the distal aspect of the paraconal root are two punctures near the cervico-enamel junction, and a larger circular puncture occurs on the distal aspect of the middle of the metaconal root. Two more are present on the mesial aspect of the para- and protoconal roots.

The breaches of the enamel are presumably traumatic, incurred in mastication by piercing and shearing of bone, particularly as the fossil and *T. cynocephalus* comparative materials exhibit similar lesions. The puncturing of the roots is harder to explain, and may be post-mortem damage. The relatively thin enamel in this specimen parallels the relatively thin enamel in any other thylacine teeth we have examined. In proportion to tooth size, it is relatively, as well as absolutely, much thinner than in human dentition.

Mesial surface of the crown: A relatively shallow cleft intervenes between protocone and paracone and subtends an angle of 140°. There is no interproximal attritional facet on the mesial aspect; but there is a vertical gouge on the protoconal cingulum; apparently there was not direct contact with distal extremity of the upper 3rd premolar. This is a variable feature in the material examined for comparison.

Staining and cracking: Stemming from the cervico-enamel margin or close thereto, a series of parallel cracks run occlusal-ward. On the buccal aspect, 26 can be counted with a lens; the majority extend over the cingular bulge, but 6 are larger and reach almost to the summit of the crown. A further 28 occur on the palatal aspect, the majority extending at least half way towards the summit. An irregular branching fracture runs longitudinally, intersecting the larger fractures in the parallel vertical series. A more gross and recent looking fracture (unstained) runs obliquely across the palatal aspect of the junction of metaconal apex and spur; another curiously zig-zag hair-line crack (heavily stained) runs parallel and adjacent to the enamel margin of the metacone. On the mesial and distal aspects, cracking is more irregular and curvilinear. The enamel adjacent to the cracks is stained a medium brown which becomes progressively lighter as distance from the crack increases. The enamel, therefore, presents the curious impression of being vertically striped near its margin. The staining is more intense at the larger cracks. Obviously, the stain (probably ferruginous) has invaded the tooth via the cracks in the enamel. The pattern of cracking suggests a progressive post-mortem process, the vertical series being oldest, the transverse and oblique series more recent.

The Roots: The roots are much more intensely stained a dark chocolate brown; each cusp is independently supported on its own root.

Root lengths are protoconal 6·6 mm, paraconal 6·6 mm, metaconal 6·4 mm; their mesio-distal diameters adjacent to the crown are 2·8, 2·6, 3·8 mm respectively.

The paracone root is cylindrical in cross section, progressively tapers to the slender apex and is strongly curved in a palatal direction at the junction of its basal two thirds and its apical one third. The extremity of the tip is recurved bucally and distally.

The protocone root is compressed obliquely near its base resulting in a somewhat triangular cross section; in its middle third, cross section is circular. Its distal third is slightly bent buccally. Its buccal aspect is slightly guttered.

The metaconal root is strongly compressed bucco-palatally. Its distal border is straight and its mesial borders strongly curved. A very deep gutter excavates the basal two thirds mesially, shallowing in the distal one third. The tip deviates palatally. A mesio-distal ridge traverses the floor of the root fossa. The roots merge into the body of the tooth smoothly but are considerably overhung and sheltered by the cingular bulging of the enamel. Each root is united to its neighbour by a buttressed arch.

Radiological Examination: The canals are of relatively large calibre and single for each root; the pulp cavity is uncomplicated, and its cornua follow the external contours of the tooth. Thinness of the enamel is confirmed.

Statistical Analysis

(1) 18 crania of *Thylacinus cynocephalus* (Harris) from Tasmania (Australian Museum No. 768, 769, 770, 771, 774, 775, 776, 778, S401, S402, S789, S1180, S1730, M1821); Macleay Museum (University of Sydney) No. M1000, M1001, M1002; Anatomy Museum (University of Sydney) No. SF5: 32. Crania modern but lacking sex and precise locality data.

(2) Thylacine upper left 1st molar from Fromm's Landing, SE. South Australia.

Left M^1 of *Thylacinus cynocephalus* (Harris)

	Mean mm	95% confidence interval for mean mm	Number	Standard deviation	95% confidence interval for standard deviation
M^1 length	11·05	10·78–11·32	18	0·539	0·404–0·809
M^1 width	7·93	7·75– 8·11	18	0·371	0·278–0·556

Regression of molar width on molar length
$\beta = 0{\cdot}636$ 95% confidence interval 0·498–0·774

Regression of molar length on molar width
$\beta = 1{\cdot}346$ 95% confidence interval 1·054–1·638

Fromm's Landing thylacine:
Left M^1 length 8·9 mm; Left M^1 width 6·4 mm;
t value for molar length 3·880; t value for molar width 4·017.

The probability that the Fromm's Landing thylacine measurements for molar length and for molar width belong to the distribution shown by modern Tasmanian *Thylacinus cynocephalus* is less than 0·01 and 0·001 respectively. Relevant, however, is the statement by Thomas (1888, 257) that the two sexes in *T. cynocephalus* differ in their cranial and dental characters far more than do the sexes of any other marsupial. Therefore, consideration must be given to possible sexual dimorphism in molar size when evaluating the taxonomic significance of the results obtained by the present analysis.

Estimated lines for regression of molar width on molar length and of molar length on molar width are drawn in Fig. 4 for *T. cynocephalus*, and the position of the Fromm's Landing Molar is indicated in the same figure. The Fromm's Landing molar is seen to lie close to the extended regression lines for *T. cynocephalus*.

We thank Professor H. O. Lancaster, Dept of Mathematical Statistics, and Dr A. A. Day, Dept of Geology and Geophysics, University of Sydney, for discussing the statistical analysis.

Conclusion

The tooth is a thylacine permanent upper left 1st molar. In four traits—miniature size, bifid protocone, absence of a definitive style c2, presence of a minute style buccally on the extremity of the metaconal spur—it differs from the comparative material of *T. cynocephalus* examined by us; in all other morphological traits and in metrical proportions, it is identical or within the range of individual variability of *T. cynocephalus*. We consider the four outstanding differences, when summated, prevent inclusion of the Fromm's Landing Tooth in *T. cynocephalus*.

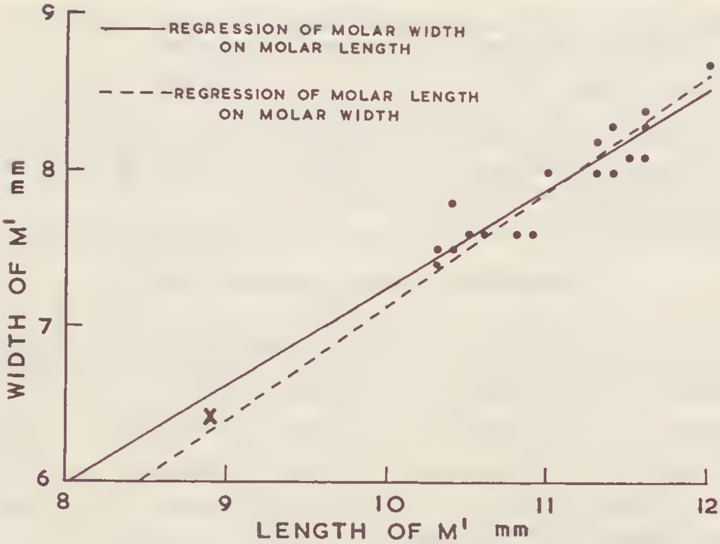

FIG. 4—Regression lines for *T. cynocephalus*.
Legend: • *T. cynocephalus* (Tasmania)
× Fromm's Landing (Mainland, S. Aust.)

Small forms have not been recorded for fossil species of *Thylacinus*; indeed, Lydekker (1887, 264) and De Vis (1894) indicate that these species are no less robust and are perhaps more robust than *T. cynocephalus*; however, the named fossil species of *Thylacinus* have not been defined adequately.

The Fromm's Landing thylacine is known to us from a single tooth only, and so specific determination of this animal is premature at this stage and it is recorded here as *Thylacinus* sp.

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Explanation of Plates

PLATE LXVIII

View of trench looking N., 1963.

PLATE LXIX

General view of part of N. wall showing erosion of layers by flood and subsequent deposition.

PLATE LXX

Detailed view of flood sediment.

PLATE LXXI

A. Burial 1; B. Burial 2.

PLATE LXXII

Fromm's Landing Dingo. Note immaturity indicated by ununited epiphyseal junctions. The vertebrae have been assembled in completely adjacent contact; by calculation, allowance for intervertebral discs would add 4·0 cm to the length of the vertebral column. Reconstruction and reassembly by Burton Bailey and N.W.G.M.; photo by G. L. Williams, scale by K. Smith, Dept of Anatomy, University of Sydney.

PLATE LXXIII

A. Fromm's Landing Dingo, paraffin coated as delivered. Note: Vertical aspect of right side of skull at margin of block; thigh bones fully flexed at hip joints; knee joints semi-flexed; left side of skull rests on left scapula and left forelimb bones which are fully flexed and tucked under against chest wall. Scale and photo by K. Smith and G. L. Williams, Dept of Anatomy, University of Sydney.

B. Reconstructed skull. Note permanent dentition and fully erupted, well formed lower 3rd molars; the left lower 2nd molar was not recovered. Note also the uninterrupted and unreduced cingulum on the upper 1st molars. Photo by G. L. Williams.

PLATE LXXIV

Upper left 1st molar *Thylacinus* sp. Greatest length 8·9 mm. 1. Buccal, 2. Palatal, 3. Mesial, 4. Occlusal, 5. Distal. Photo by G. L. Williams and D. H. Joy, Dept of Anatomy, University of Sydney.